SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1917 by Munn & Co., Inc.

VOLUME LXXXIII
NUMBER 2140

★ NEW YORK, JANUARY 6, 1917 ★

$5.00 A YEAR
10 CENTS A COPY

Jan.-June 1917
FR 605 V.83
COP. 8

A recently designed American armored automobile.

MAR 30 1971
SEP 26 1917

ARMORED AUTOMOBILES.—[See page 4.]

DEC 16 1929

SEP 2 6 1917

The Municipality in Industrial Hygiene*

New Methods for the Protection of Public Health

By Louis I. Harris, M.D., Chief, Division of Industrial Hygiene, Bureau of Preventable Diseases. New York Dept. of Health

It has been argued that the evils and abuses which characterize medical practice, as it is generally conducted among the middle class and the poor in our population, can ultimately be remedied only by making the protection and maintenance of health in the community a State function. This belief is fast gaining approval and, with the enactment of laws for compensation in cases of industrial accidents and diseases, and with compulsory health insurance legislation almost an accomplished fact, we stand upon the threshold of a new era in medicine. The next stage after the formation of panels of physicians to treat the sick among a fraction of our industrial groups in this country, under the terms of the proposed health insurance law, is the extension of the same system of medical care to ever-widening circles of our population. For the abuses which will undoubtedly arise under the new system, appropriate remedies will in due time be found, and physicians will ultimately be removed from the economic necessity of grappling with each other in mutually destructive competition that demoralizes the practice of medicine. The recent outbreak of acute anterior poliomyelitis in New York City well demonstrated, if, indeed, further demonstration was necessary, that no group in a community, however rich and well-guarded, is safe unless all other groups are equally protected from the visitation of disease; the most effective safeguard, therefore, lies in public health medicine and in other measures of prevention applicable to the community as a whole.

Industrial hygiene will soon emerge as a branch of preventive medicine so closely interlocked with the welfare of society as a whole that, from the very outset, it should be clearly kept in mind that it is necessarily and in essence a function of government. It should never be permitted to lapse into a form of privately administered philanthropy or charity, to suffer from the abuses and evils that have marred the practice of medicine carried on as an individual business. Just as compensation for industrial accidents has not been left to the benevolent impulses of individual factory owners, but has been adopted in thirty-four States as the legal right of the worker, so industrial hygiene should be administered with legal sanction to compel proper environmental and industrial conditions in all shops, factories and mercantile establishments. If these propositions are accepted, it follows, since industrial hygiene has but comparatively recently been born into the family of medical sciences, that so far as possible uniform standards and uniform requirements should, at the outset, be agreed upon, in order to avoid a confusion of counsel and working at cross purposes. The Federal Government, the American Public Health Association, and the American Medical Association would obviously seem to be the best agencies to work in concert for the formulation of such uniform standards and requirements as regards ventilation, lighting, heating, disposal of dust, fumes and gases, etc. Courts of law would, as a result, be in a measure compelled to rule in accordance with the consensus of opinion as expressed by such an authoritative concert as the three agencies mentioned, in cases brought to trial.

If the American Public Health Association were to set in operation a movement to unite upon standard measures for guidance in industrial hygiene work, harmony of effort throughout the country would be more likely to follow.

It is not to be expected as yet that the Legislatures of the National, State and Municipal Governments, respectively, would keep pace with each other in their legislative acts to conform to any proposed standard, but surely that should be our ultimate goal everywhere except in so far as local industries may be unique and not conformable to the general standards. The Federal, State and City Governments should each, within the respective precincts of their authority, carry into effect the laws relating to industrial hygienic supervision. The unfortunate dissensions between State and Municipal authorities, who should enjoy fraternal relations, and who, instead, are frequently at loggerheads, thus retarding the progress of industrial hygienic work, should be eliminated. Team work is indispensable.

In the absence of definite standards, it may be of interest and serve as the basis of discussion of the proper functions of a municipality, to describe what the City of New York has attempted in the field of industrial hygiene.

The Division of Industrial Hygiene of the Bureau of Preventable Diseases was organized in March, 1915, for the purpose of studying and regulating conditions affecting the health of workers in the various industries carried on in the City of New York.

The Sanitary Code was reinforced so as to give the Department of Health special powers in the field of industrial hygiene by the addition of the following two sections:

Section 321.—*Occupations and businesses, dangerous or detrimental to life or health, prohibited.* No occupation or business that is dangerous or detrimental to life or health shall be established or carried on in the City of New York.

Section 337.—*Duty of employers to provide means to prevent occupational diseases.* Every employer shall provide reasonably effective devices, means, and methods to prevent the contraction by his employees of any illness or disease incident to the work or process in which such employees are engaged.

The investigation of factory conditions has been based on information obtained through four sources:

(1.) Complaints of citizens calling attention to alleged violations of the Sanitary Code or conditions that are thought to be detrimental to the health of workers. Such communications, whether anonymous or signed, lead to a careful investigation of factory, shop, or office conditions by the Division of Industrial Hygiene. Complaints of this character are becoming increasingly numerous as the public is becoming acquainted with the facilities available. They have stimulated the division to make studies of a number of industries.

(2.) Physicians, dispensaries and hospitals are required, by a provision of the Sanitary Code, to notify the Department of Health of every case of occupational disease that comes under their care. The Division of Industrial Hygiene in the course of the first sixteen months since it actively began work, has received 17 reports of cases of occupational disease from private physicians, and 52 from hospitals and dispensaries. As against this total of 69 cases of which we have been notified by physicians and institutions, our occupational clinic has reported 207 cases. The latter consisted of 46 cases of mercury poisoning among 347 felt hat workers who were examined; 97 cases of lead poisoning and 63 of turpentine poisoning among 289 painters, and 1 case of arsenic poisoning in a packer of Paris green.

If our occupational clinic, with its restricted opportunities for study, has so far run ahead of the private and institution physicians in recording cases of occupational disease, it seems reasonable to suppose that a campaign of education among medical students and among private physicians who, in their professional work, at some time or other minister to persons exposed to a great variety of occupational diseases, would serve to give the importance of occupational disease influences, and the resulting diseases they cause, the emphasis they deserve. This educational campaign should begin with the medical student. Considering the powerful impulse that has been given to manufacture by the European war, and bearing in mind that American municipalities are, as a rule, veritable bee-hives of industry, it should be clear to physicians in general that they have a great moral responsibility in reporting occupational diseases to their respective Health Departments. Prompt notification makes possible the investigation of factory conditions that menace the health of many other workers than those who are reported, and gives public health authorities an opportunity to put into effect appropriate sanitary regulations. The advent of compulsory health insurance will, no doubt, bring such preventive measures prominently to the front. Efforts to safeguard the health of the worker will then be put forth, not only by the relatively few employers who are in the vanguard in this respect, but, under legal compulsion, all employers will awaken to the value of disease prevention, as they did to that of accident prevention when compensation for accidents became a law.

The scant number of occupational disease cases reported by private physicians and hospitals is to be ascribed only to the failure of medical colleges and public health officials to perceive the far-reaching importance of the occupational causes of disease and to give it adequate emphasis. The time is now at hand when an active campaign to secure notification of these diseases must begin in a manner comparable to that carried on twenty years ago to secure the reporting of tuberculosis.

Our form of postal card for use in reporting occupational diseases is based on Section 92 of our Sanitary Code, and makes it obligatory upon physicians to report diseases caused by the following agents:

Lead	Phosphorus
Arsenic	Bronze
Mercury	Wood Alcohol
Aniline	Gases (Illuminating and others)
Brass	
Acids	Anthrax
Caisson Disease	Wood Naphtha
Bisulphide of Carbon	Natural Gas
Dinitrobenzene	Carbon Monoxide

In addition, physicians are urged to inform the department when, in their opinion, the following diseases are of occupational origin:

Tuberculosis	Asthma
Pneumonia	Bronchitis
Circulatory Diseases:	Nephritis
Arterio-Sclerosis	Skin Diseases
Apoplexy	Nervous Diseases
Endocarditis	Orthopedic Defects
Myocarditis	

(3.) All death certificates examined by the Bureau of Records which give lead poisoning, caisson disease, industrial wood alcohol poisoning, anthrax, or any other occupational disease as the cause of death, are referred to the Division of Industrial Hygiene for investigation. It is as the result of such scrutiny of death certificates by the Bureau of Records that two cases of death and two of permanent blindness from wood alcohol, occurring within twenty-four hours among men who were painting the interior of beer vats in a brewery, were discovered by the Division of Industrial Hygiene in the course of its investigations in December, 1915. This study led to active efforts on the part of the commissioner to induce brewers to prohibit the use of wood alcohol in shellac used for painting the interior of beer vats, and, as a result, a Brewers' Association, comprising, among its thirty and odd members, all the brewers of Greater New York and several of New Jersey, adopted resolutions in accordance with the commissioner's views. An addition to the Sanitary Code forbidding the use of wood alcohol under similar conditions is being prepared.

Anthrax has been similarly studied as a result of cases of death from this disease reported to the Department of Health, the Research Laboratory assisting by making bacteriological examination of samples of hide in the various stages of the curing or tanning process.

(4.) Intensive studies have been made in specially selected industries, such as the fur and the hatters' fur trades, painting, rag sorting, and the work connected with the filling in with ashes of swamp grounds on the Flushing Meadows. Eight hundred and eighty-nine workers in the fur and hatters' fur trades were examined by our clinic staff. The results of this clinical and sanitary study have been embodied in a special monograph printed by the Department of Health, which shows the incidence of tuberculosis, asthma, dermatitis, mercury poisoning, etc., in these trades, as brought out in our study. A progress report on the results found in the examination of 338 painters is now ready. This report will be subsequently elaborated and prepared for publication.

Our examination of about 100 rag sorters was surprising in that they were found to be a comparatively robust and healthy lot despite their exposure to dust and work in poor surroundings for long periods of time.

The examination of 119 men who had been employed for periods varying from one to four years in filling in the swamp lands on the Flushing Meadows with ashes collected by the Street Cleaning Department was the first intensive study undertaken by the Division of Industrial Hygiene. Notwithstanding the fact that the men employed on the meadows worked day in and day out in an atmosphere thick with ash dust and other refuse, and lived in veritable hovels, eating their lunches in pits while ashes were being dumped all around them, not a single case of tuberculosis was found among them.

*First Annual Report of the Division of Industrial Hygiene. Read before the American Public Health Association, at Cincinnati, October 25, 1916.

The records of the Health Department Tuberculosis Clinic in the district in which they reside were closely examined and not a single case could be traced back to this work for the four years since the filling-in was begun. Aside from a few cases with cardiac lesions, the only defects that were prominent were hypertrophic rhinitis and chronic pharyngitis, and a number of cases of corneal opacity or conjunctivitis resulting from particles of irritant dust.

Fourteen deaths from anthrax that occurred during the year received newspaper notoriety that created an unwarranted feeling of apprehension in the mind of the public as to the danger of contracting this disease from the wearing of cheap furs. A number of cases were investigated by the Division of Industrial Hygiene and only two were found to be employed in handling hides or leather. In the other cases, the origin of the disease remained undiscovered. An investigation of the handling and curing of hides was made and specific recommendations for the protection of those engaged in this work prepared. Of other activities initiated by the Division of Industrial Hygiene, four that deserve special mention are:

1.—Investigation of department stores.
2.—Supervision of city contract labor.
3.—Follow-up of children entering industries.
4.—Co-operation with labor unions in factory sanitation.

1.—All department stores in the city have been made the subject of special study, and the list of industrial hygienic defects found in the respective stores in the course of the visits made by the inspectors was submitted to the association of department store owners—the Retail Dry Goods Association. After explanation of the requirements of the Sanitary Code and the benefits to be derived from careful provision for the health of employees, the owners have been given an opportunity to make changes in conformity with our recommendations, so as to avoid the necessity of resort to legal enforcement of the requirements of our Sanitary Code. This method is especially valuable, inasmuch as an enlightened and sympathetic attitude on the part of employers can produce results of a far higher standard than the legal requirements. A reinspection has now been begun as an initial step in enforcing the provisions of law in those stores where employers have not voluntarily complied with recommendations.

2.—So much work of a hazardous character is required in the construction of subways and other public utilities, as well as in the construction, care and equipment of the many buildings belonging to the city government, that it has seemed but just that the numerous workers engaged in work done for or by the municipality should be beneficiaries of the supervision and guidance of the Division of Industrial Hygiene.

As a beginning in this direction, the conditions under which painting is done on public buildings have been studied in conjunction with Dr. Alice Hamilton, an authority in such investigations, who represents the Bureau of Labor Statistics of the United States Department of Labor. The results of this study will be incorporated with the report on the clinical findings in our study of 338 painters.

3.—The valuable contribution to preventive medicine brought about by the vigorous campaign in the field of child hygiene ends abruptly, as a rule, with the issuance of working papers. In order to continue such health supervision, the Division of Industrial Hygiene is co-operating with the Trade School for Girls of the Department of Education and is conducting careful clinical examinations to ascertain their physical fitness for their special industrial requirements. Follow-up work, to inspect the shop or factory and the home environment, has now been begun in order to guard the child against the hazards of industry by timely counsel to parents and to trade school teachers. The girls are also examined several times a week to exclude those showing signs of contagious disease, and lectures are given on hygiene.

4.—Instead of depending only upon complaints of citizens to initiate our efforts in industrial hygiene, a new plan for action has been developed in co-operation with labor unions. Typographical Union No. 6 has been the first to print and distribute a circular prepared by the Division of Industrial Hygiene in conference with its hygiene committee, setting forth the industrial hazards which are of importance in the printing trade, and urging all of its members to seek to secure their elimination by personal appeal to employers, failing which the Division of Industrial Hygiene is notified, and such legal action undertaken as seems warranted by investigation.

EDUCATIONAL ACTIVITIES.

Aside from the publication of a monograph detailing the clinical and sanitary findings of our study of the fur and hatters' fur trades, a placard, for display in printing shops giving precautions to be observed by printers, has been prepared. Also, there has been distributed among union painters 10,000 copies of a questionnaire which outlines the principal signs of lead, turpentine, wood alcohol, benzine and benzol poisoning, and urges upon the painters the necessity of consulting their private physicians or the occupational clinic staff if there appears reason to believe that any form of occupational disease exists. Health suggestions for bakers are now ready for printing, and appropriate advice on health matters is being prepared for other trades. A monograph intended to serve as a guide in factory sanitation and hygiene to factory owners is now ready for the printer.

Over twenty-eight lectures on industrial hygiene were delivered last year before various medical societies, civic organizations, private organizations, labor unions, and in public schools. In all, about 18,000 persons were reached through the lecture platform. Addresses have also been made before various manufacturers' associations with a view to enlisting their support in this work.

OCCUPATIONAL CLINIC ACTIVITIES.

During the first year of active work at the Occupational Clinic, the following groups were examined by the clinic staff:

Industrial Groups.	No. Examined.
Bakers	8,912
Peddlers	8,236
Waiters, Cooks and Other Food Handlers	23,440
Furriers	886
Painters	255
Trade School Girls	110
Miscellaneous Industries	203
Total	42,042

The examination of food handlers was begun on August 1, 1915, in accordance with the provisions of Section 146 of the Sanitary Code, for the purpose of detecting and excluding all who come in contact with food in public places and who are found suffering from an infectious disease in a communicable form. Subsequently this regulation was extended to include all those who handle food in hospitals, foundling asylums and similar institutions, in order to protect invalids and children from persons suffering from tuberculosis, syphilis, gonorrhoea and from typhoid carriers. This examination is now required of all who handle the milk supply, from its source to its destination. There are in the City of New York approximately 90,000 restaurant employees, and 750,000 food handlers, if one includes all employed in food manufacture, butchers, grocers, confectioners, delicatessen dealers, bartenders and others.

It was noted that the regular staff of the Occupational Clinic examined a total of about 40,000 food handlers in nine months, and that it could not hope successfully to cope with the problem of examining any significant fraction of the total number of food handlers without substantial aid from other sources. Accordingly, private physicians in this city and in many parts of the State were permitted to carry on such examinations of restaurant workers and milk handlers under control and supervision by the Division of Industrial Hygiene. In the period of nine months beginning August 1, 1915, 1,196 physicians applied for permission to conduct such examinations.

All persons to be examined are referred to the Food Division of the Bureau of Foods and Drugs of the Department of Health. To the latter division is referred a list of all cases to be excluded from work and the inspectors of the Food Division put these recommendations into effect.

SOCIAL SERVICE AND HOME VISITING.

To a medical adviser, whose services are paid for by the American Museum of Safety through a fund established by Mrs. E. H. Harriman, all cases that show incipient or advanced pathological conditions of any description are referred for general hygienic advice. The medical adviser, when necessary, seeks to persuade such persons to place themselves under the medical care of their family physicians, or, when this is impossible, he refers them to a reputable dispensary or hospital. A social service nurse follows the patient up to his home, to secure compliance with the medical adviser's recommendation and to assist in obtaining financial or other aid, if such aid is necessary. The nurse seeks to gain the friendship of the family, and to advise as to diet, ventilation and domestic hygiene.

Those who suffer from occupational diseases are visited at their homes to determine the degree to which the home contributes to the existence of the disease. Persons whose health is shown to be jeopardized by a continuance of work in their special industry are urged, if possible, to take up some different line of work, and a more healthful occupation has been secured for several of these. Financial aid is obtained from the Harriman Fund in deserving cases. The unemployed are assisted to gain employment through the Municipal Employment Bureau.

INDUSTRIAL EXHIBIT.

Since so many thousands, perforce, visit the Occupational Clinic annually, the American Museum of Safety was persuaded to establish a branch in the clinic. This nucleus of an industrial exhibit consists of wax casts, plaster models, photographs, casts of diseased organs, placards, an electric illusion and display board on dental hygiene, legends and charts.

LESS IMPORTANT CLINIC ACTIVITIES.

The blind men who work in the shops of the New York Lighthouse are examined periodically to discover incipient pathological conditions that would make exposure to the dust of their occupations injurious.

Laundresses, who are also trained by the New York Charity Organization Society to do domestic work in private homes, are examined as to their freedom from infectious diseases. This is possibly the beginning of an extension to groups other than public food handlers, of that supervision which has for its object the exclusion of those who may disseminate infection through occupational contact.

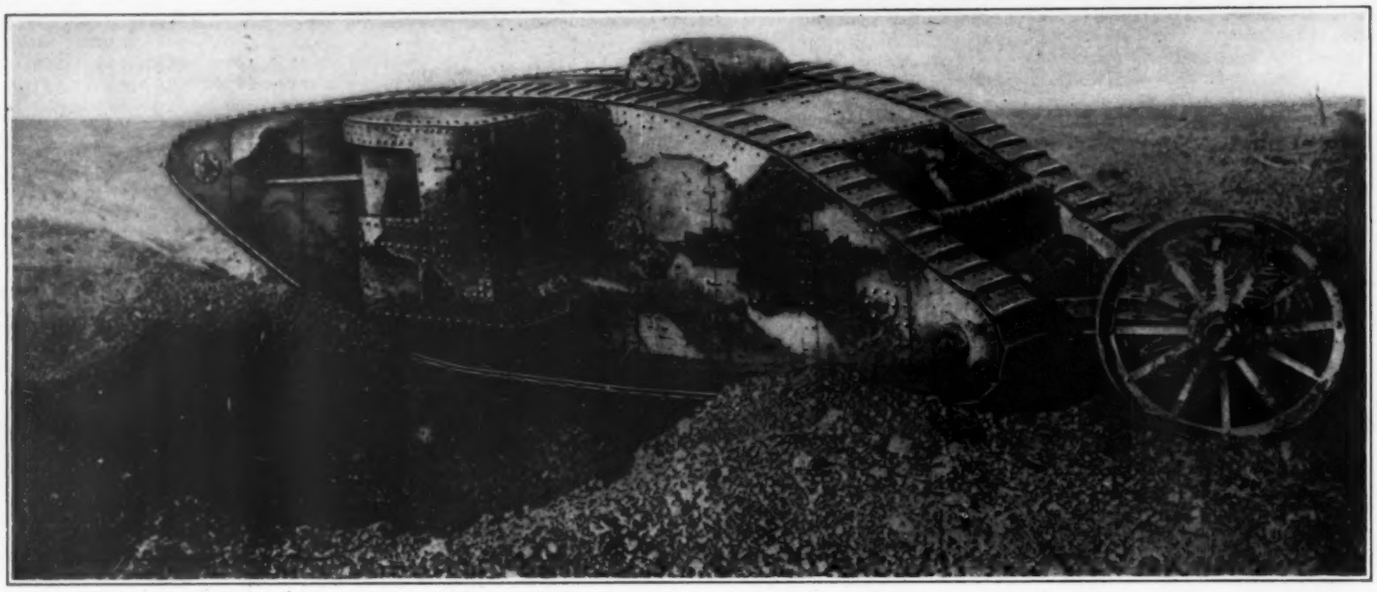
Finally, through the efforts of Dr. Donald B. Armstrong, director of the Department of Social Welfare of the Association for Improving the Condition of the Poor, nurses who are taking the course in public health at the New York Teachers' College have just been enlisted as volunteer social service workers and as general assistants for training in clinical and field work in industrial hygiene.

Two branches of the Occupational Clinic have been established in the boroughs of the Bronx and Brooklyn, respectively, for the convenience of persons living in those boroughs.

While, strictly speaking, food handlers' examinations are conducted for the discovery of communicable diseases, it is interesting and instructive to note how many observations can be made incidental to such examinations. Crude as the methods of the clinic staff necessarily have been, owing to the confusion and changes incident to organization, it is striking that among a group of persons presumably healthy so large a percentage of pathological conditions should have been discovered.

Trajectories of Projectiles Discharged at an Elevation of 45 Degrees

MANY months have elapsed since the newspapers mentioned a bombardment of Dunkerque by a German gun at a range of more than twenty miles. Very little, if anything, has been heard of that gun since. The news, however, induced M. de Sparre to address several communications, in December, 1915, and in January and April last, to the Paris Academy on the trajectories of projectiles discharged with high velocities at elevations of about 45 degrees. He points out that projectiles would, under these conditions, rapidly enter layers of an atmosphere of very much reduced density, and he calculates the trajectories on the basis of the formulæ of Charbonnier and of Siacci, which he extends for his purpose. Assuming that the gun has a caliber of 381 millimeters and that the projectile weighs 720 kilogrammes, and accepting the figures for normal German ordnance as given by Cranz and others, including the ballistic index of 0.865, he calculates that the high elevation of 45 degrees increases the range by from 35 to 40 per cent and by about 10 kilometers in this instance. The velocity of the projectile would pass through a minimum after the shell had reached its summit, and then increase to a maximum, finally to decrease again. In his last communication he considers that the index 0.865 is probably too high, and he recalculates his data for a ballistic index of 0.75. The velocities he arrives at for different parts of the curved trajectory are: 940, 592, 443, 386, 394, 437, 433 meters per second, these figures corresponding to curvatures (in round figures) of + 45 degrees, 36½ degrees, 20⅔ degrees, 0 degrees, — 25 degrees, — 45½ degrees, — 58 degrees. He also makes calculations for another gun of 406.4 millimeters, discharging shells of 920 kilogrammes weight; in this case he deduces a maximum range of 40 kilometers. Finally he inquires into the influences of temperature and barometric pressure. Those influences would be exceedingly strong, both a fall of temperature and a rise of the barometer tending to shorten the maximum range very considerably. In comparison tables he gives the results of calculations made for an atmosphere of constant density.—*Engineering.*



Photograph from Underwood & Underwood, N. Y.

One of the "Insolent" British tanks, employed on the Somme front.

Armored Automobiles

A War Machine That Has Undergone Many Changes

It is safe to say that there is not an appliance used in warfare that has not undergone radical revision and improvement since the beginning of the European conflict, partly as a result of experience gained, and partly of necessity to meet the ever changing conditions that develop so rapidly in every branch of service; and among these the armored car has been the subject of particularly sensational development. This was to be expected, for this is the first time that the automobile has been called into actual service by armies in the field, and previously it can hardly be said that the motor vehicle had been very seriously considered as other than for the transportation of supplies.

Soon after the invading armies had penetrated Belgian territory rather exaggerated stories began to appear telling of the doings of the automobile in rapid forays conducted by both the Belgians and the Germans, for which purpose it was found extremely useful; but these cars were crude and hastily extemporized affairs, made by mounting a few steel plates on an ordinary pleasure vehicle in such a way as to afford a partial protection to the occupants of the car, and to the vital parts of the mechanism. Notwithstanding their evident imperfections the value of an armored automobile as a fighting machine in open country was quickly recognized, and a host of improved designs soon appeared on the scene, all of which not only provided more elaborate and effective protection for the occupants, but greater offensive power than was possible in the first make-shifts, for, instead of a few men armed with the ordinary military rifle, accommodations were arranged for machine guns, and frequently, also, for one of the smaller sizes of rapid fire guns, which were sometimes mounted in small revolving turrets that made it possible to fire them in any direction.

Many are the tales that have come to us of the successes of fighting cars of this description, in scouting expeditions, in attacks against outposts and surprise demonstrations leading up to attacks in force; but when the advance of the central powers was checked, and both sides "dug in," making the situation one of mutual siege, the armored car apparently disappeared, as it was not powerful enough to meet the heavy concentrated fire then to be met, and, moreover, with the destruction of everything resembling a road in the neighborhood of the fighting lines, the light armored automobile was put out of the running, as its ability to negotiate rough ground is decidedly limited, and it could by no means surmount shell craters, much less jump trenches, and for a time it looked as if its course had been run.

On the Eastern front, however, the operations were of a more open character, and soon we heard of the excellent service the armored car was doing there, where in some cases Russian cars broke through the opposing lines, and, opening an attack from the rear, contributed largely to important successes. Then came the Egyptian campaign, and here again, in open country, the armored automobile played an important and valuable part in breaking up scattered bands of opponents, maintaining telegraph lines and carrying dispatches through long stretches of hostile country.

More recently, one of the most sensational developments of the war was disclosed by the unexpected advent of the British Land Ships, as they are officially rated, but more popularly known as the "tanks," and thus was the armored car reincarnated in a surprising, but vastly more powerful and effective form, for it is not only capable of being operated over what has heretofore been considered impossible surfaces, but it is also proof against the attacks of anything short of powerful field guns, and is itself armed with heavier and more efficient weapons than any of its more agile predecessors.

The first reports of the tanks were of such a fantastic nature as to raise doubts of their veracity, for war correspondents, guided only by the camp gossip that filtered through devious channels, vied with each other in drawing verbal pictures of the new monster as a mechanical Behemoth, an Ichthyosaurus, or a Diplodocus; but for once these stories proved to be not so far from the mark as too often happens when writers for the daily press fall foul of a technical subject, for the tank is like unto nothing heretofore seen on wheels.

One of our illustrations shows a tank in actual field work, sliding serenely over a shell crater, and it will be seen that it consists of a small portable fort of steel that is invulnerable against any weapon usually found in advanced positions. This is provided with a sponson on either side containing a powerful rapid-fire gun, so mounted behind movable shields that it can cover quite an extensive field of fire. Probably the tank also carries several ordinary machine guns, although the photograph does not show them, and no details of the interior arrangements have been so far disclosed. This fort is mounted upon two endless corduroy belt tracks, one being disposed longitudinally on either side, and at the rear are large flanged steering wheels. At the forward end the track is carried upward at an angle, and this enables the machine to lift itself out of shell craters and similar depressions, while the balance of the outfit is said to be so adjusted that it will span any ordinary trench before the front end drops materially from the horizontal. The tank shown in the picture appears somewhat dilapidated, but while some of the markings may be due to dirt and the effects of gun-fire, most of the variegated effects are the result of the system of "protective painting" which has been adopted, for all of the tanks are irregularly painted in browns, greens and yellows that harmonize with the landscape and make them difficult of detection at a short distance. This method of deceptive coloring, by the way, is by no means new, but has been extensively applied to field guns and other exposed objects in the field.

While the tanks are undoubtedly powered by large engines, their speed is very slow, averaging probably not over 1,000 yards an hour; and this is but reasonable, for no vehicle could be expected to traverse a region torn into shell craters, and intersected by trenches, much faster than this. It is safe to say that, even if the machine were capable of greater speed, and could withstand the shocks incident to such running, its occupants could not, and still conduct the operations that are expected of them.

The powers of destruction attributed to the tanks are astonishing, and it is claimed that not only do forest trees offer no obstacle to their progress, but that their impact easily breaks down large tree trunks, when the machine rides unobstructed over the stumps. Masonry buildings of considerable size suffer the same fate, and they have several times been used to oust concealed riflemen entrenched in such structures.

A few short extracts from English papers relating to the tanks may be appropriate. The London *Times* quotes an officer as saying: "huge shapeless bulks, resembling nothing else that was ever seen on earth, which wandered hither and thither like some vast antediluvian brutes which Nature had made and forgotten.

"I watched the great things maneuver about the field, grotesque and unspeakable; and at each new antic which they performed, each new capacity which they developed, one could do nothing but sit down and laugh till one's sides ached. Were they only a preposterous joke or were they a serious contribution to modern warfare? . . .

"Of course, they are only an experiment; but on their first day they justified themselves completely. In one short hour they did more military service, killed more enemy in uniform, and had a greater influence on the war than all the Zeppelins have ever done."

It remains to be seen what the Germans will devise to checkmate these surprising machines.

What it is like inside a tank when in action, is suggested by the following extract from the diary of one of the crew, which appears in *The Motorcycle* (London):

"Monday.—Out in a fog. Completely at sea for first part of day, traveling at rate of 1,000 yards per hour. Furious gun fire and ceaseless racket of machine guns. Enemy attack. Enough lead to smother us. Came through unscathed. Went blindly at foe. Terrible crash and ceaseless jolting. Up and down like a switchback. Dashed into a party of enemy, and crushed them under machine.

"Tuesday.—Out in abominable weather. Gun fire all the time. Vicious rattling on our metal hide. Machine

guns everywhere; passed through without a scratch. Seemed to run into an earthquake. Nothing serious; only an enemy trench. Suddenly everything seemed to go wrong. Could not make the old thing move as much as half an inch. Stranded! Enemy thought we were done for and closed in with great glee; came right up to us. Still no sign of life; then sudden recovery. We opened fire; enemy went down like ninepins. Ship gave sudden lurch, then on as fast as we could. Enemy had not time to get clear. We knocked them over, and they were crushed underneath.

"Wednesday.—Had weirdest experience imaginable just as we were well under way. There was a sudden upheaval. "Tank" seemed to be lifted from the ground and tossed sky high. Felt sure it was all over. Terrible jar back on land again. Little the worse. Enemy had sprung a mine under us. Went forward at full speed."

The latest tank story that has appeared is a report in the daily papers of some wonderful machines that the Germans are said to be using in Roumania. These cars, we are told, have wheels shod with solid rubber tires a foot wide, and are capable of a speed of twenty-five miles an hour, which enables them to scout ahead of cavalry. On its face this story is misleading, for the machine described is not in any sense a "tank," but merely a variety of the ordinary armored car of two years ago, although with possibly some minor improvements. Twelve-inch solid rubber-tired wheels can be seen on motor trucks daily in the streets of any American city, and such wheels would not enable the cars to traverse a country riddled with shell holes, much less trenches. Moreover, the speed claimed, while possible on many ordinary roads, would be absolutely impossible across country, for reasons already stated when speaking of the British creations. The entire story is apparently merely the conception of a poorly informed correspondent seeking a sensation.

The origin of the tanks has been much discussed, and many people have laid claim to originating the idea, and making suggestions. Obviously, the general suggestion came from tractors with similar propelling devices that are familiar in some sections of this country, many of which have been sent abroad during the past two years. That, however, is but one element in the design, and much ingenuity has been displayed in the combination and adaptation of apparently necessary features. To inquiries by the English public a Government official in Parliament has given credit to about a dozen people as having had a hand in producing the tanks, but no intimation was given as to what each one contributed.

The picture on the cover of this issue shows a recent American design for an armored car, which is built up on a regular pleasure chassis; and something of this type undoubtedly would be most generally useful in this country, on account of geographical conditions, although it is probable that a more rugged construction will be found necessary. Still, no one knows what may happen at any moment, and it would be well if our designers and authorities made a careful study of every possible type of fighting motor car.

Tambookie Grass and Papyrus From South Africa for Paper Making

TAMBOOKIE grass (*Cymbopogon Nardus* var. *rallidus*) grows extensively in the Transvaal, particularly in the northern parts. The sample examined ranged in length up to a maximum of five feet six inches, with a diameter of about one eighth inch at the base. On digestion with caustic soda tambookie grass yields 37.1 per cent of an easily bleachable pulp (dry pulp referred to air-dry materials), showing an average length of fiber of 0.081 inch, and is considered to be well adapted for paper-making and to have a value higher than that of Algerian esparto. Papyrus is found in the St. Lucia Bay districts of Zululand and samples of this reed have been compared with those obtained from East Africa and the Sudan. It is easily digested with caustic soda and gives a good bleaching pulp, but the yield of pulp from the South African variety is somewhat lower than from those obtained from other parts. In the case of both these South African materials, it is considered that export in the raw state would not be profitable on account of freight, but they could be converted into half stuff for export or for the manufacture of paper locally.—*Bull. Imp. Inst., from a note in Jour. of Soc. of Chem. Ind.*

The Nyala: A Recently Discovered African Mammal

THE method of exhibiting animals and birds in artistic natural groups, amid an artificial setting that represents the region in which they are found, is being introduced into all of our best museums; and one of these groups that has recently been exposed to view in the Carnegie Museum, at Pittsburgh, is of particular interest, as it shows some fine specimens of the Nyala, or Buxton's Kudu, a recently discovered African mammal.

The animals forming the group were shot by Mr. Childs Frick in the highlands of Abyssinia, by whom they were presented to the museum. With a view to the correct mounting, Mr. Frick took photographs on the spot, which were used by the artists in painting the background and the general setting, and he also procured the seeds of several African plants common to the vicinity, which were planted and grown in the Phipps Conservatory, and these plants were used in arranging the foreground of the scene.

A fine group of Nyala in the Carnegie Museum, Pittsburgh.

This group, which is but one of nine groups of East African mammals mounted in the museum, is contained in a case 16 feet long, 10 feet deep and 14 feet high, and it was unveiled on December 1st, before a number of friends of the museum, who were invited to be present by Dr. W. J. Holland, the director of the museum.

The Damping of Waves and Other Disturbances in Mercury

IT is sometimes of great importance that the mercury be prevented from freely vibrating under the actions of a disturbing force, and this is especially true when the mercury is used in accurate scientific instruments as, for example, mercurial barometers. It has been found that the disturbances in the mercury are practically eliminated if it is subjected to a strong magnetic field, e. g., by placing it in certain positions between the poles of a strong magnet. This method may be used when it is desired to obtain accurate adjustments of mercury surfaces at sea and in other places, and is described in Scientific Paper No. 289 of the United States Bureau of Standards.

Recent Work on Tsetse-Flies

THE tsetse-flies (Glossina) continue to occupy the attention of entomologists working in tropical Africa. Dr. W. A. Lamborn has now published (*Bull. Entom. Research*, vii., part 1) a third report of his investigations into the habits of these flies in Nyassaland (see *Nature*, vol. xcvii., p. 90). He believes that an abundance of the flies usually indicates the presence of "big game" in the neighborhood; yet he doubts whether the destruction of game would be effective in reducing the numbers of the fly, because "the game, if severely harassed, will retire [to surrounding areas] during the dry season, when only it is possible to hunt, returning in the wet and probably bringing more flies with it." In the same number of the bulletin there is also a paper by Ll. Lloyd on *Glossina morsitans* in northern Rhodesia. His observations show that in districts where game is scarce tsetses are often more numerous and troublesome than where game is plentiful; he suggests that this is because the flies, in the absence or scarcity of other mammalian prey, must attack man in larger numbers and with a more violent hunger. Mr. Lloyd, like Dr. Lamborn, finds males much more abundant than females in ordinary collections of Glossina, but Dr. Lamborn points out that the proportion of females is largely increased when flies are caught beneath an umbrella or resting on trees approaching the equality with the males which is seen in flies reared from puparia. Both writers have interesting notes on species of Mutilla (described by R. E. Turner in the same number of the bulletin), the larvæ of which are parasitic in the pupæ of the tsetses, while Dr. Lamborn has shown that a small chalcid (*Syntomosphyrum glossinæ*), believed also to be a parasite of the Glossina, is really a hyperparasite on the Mutilla.

A convenient and useful summary of our knowledge of the tsetse-flies ("Notice sur les Glossines ou Tsé-tsés") by E. Hegh has been published in London under the auspices of the Belgian Colonial Ministry. It serves as an introduction to the structure, life-history, and classification of the insects in tropical Africa generally, but with special reference to the Belgian Congo. M. Hegh begins his historical introduction with the work of Bruce in 1895-1896, and seems to ascribe to that distinguished surgeon the discovery that tsetse-flies carry disease. The deadly action of Glossina on European domestic beasts was well known to Livingstone during his early African journeys, and in his "Missionary Travels and Researches" (1857) he described the effect of the tsetse's bite on cattle and horses. With a seeming prevision of modern discoveries, he wrote of the "germ" of a poison "which enters when the proboscis is inserted to draw blood," and which "seems capable, although very minute in quantity, of reproducing itself." Bruce's contribution to the subject was the demonstration of this "germ" as a flagellate blood-parasite or Trypanosoma.—*From Nature.*

What It Costs to Stop a Freight Train

UNDER the old fashioned methods of operating railroads, and not so long ago either, everyone with any authority, from the president to the section foreman, thought it perfectly proper to hold up a freight train to suit his personal convenience, but with a more accurate knowledge of costs a great change has taken place in this respect. Investigations have demonstrated that to stop the average heavy freight train from a speed of fifteen miles an hour, and to again bring it up to the same speed, means the expenditure of from 300 to 750 pounds of coal, and this means that if many unavoidable stops are made a material percentage of profits are wasted. As a consequence schedules are now arranged on well managed roads so that there shall be as little interference with the movement of freight trains as possible, even if some passenger trains have to be inconvenienced by the process.

Decay of the Teeth*

Susceptibility to and Immunity from Caries

By Earl Brooks, D.D.S.

A REVIEW of the literature concerning the theory of caries dates back for many generations and even centuries. The views and theories even only a generation ago were very vague and devoid of scientific data and proof; but, in the last ten or fifteen years, there have been various learned investigators who have taken up the subject from a scientific viewpoint, and probably more advance has been made since then in the understanding of the true conditions than in all previous investigations. Various theories were advanced in former times by different investigators; but in recent times most investigators are agreed upon the fundamental principles of caries.

With a little application on the part of the student, an understanding of the theory is by no means difficult, but we in practice too often fall into the rut of being mere machines in the performance of the daily routine of our office, not giving any time to the study of the scientific side of our work. Just here I cannot refrain from quoting the following sentence from Dr. Black: "The complete divorcement of dental practice from studies of the pathology of dental caries, which has existed in the past, is an anomaly in science that should not continue."

After considering the results obtained by various investigators, I will try in my own way to give you my understanding of the theory of caries.

Caries begins with the dissolving of the inorganic parts of the tooth structure by an acid, and subsequently followed by decomposition of the organic parts. In decay of the enamel, the dissolution of the inorganic salts is the predominating influence; but when the dentin is reached, while the inorganic dissolution precedes the organic, they are of equal importance.

The mouth harbors a great number of various micro-organisms; yet there are found only a few, possibly a dozen varieties, that are constant in all mouths, and probably some of them are not important. The acid of caries may not be produced by any of these varieties alone, but by any one or several of them. They are constant in the mouths of both susceptibles and immunes. They also produce but little more acid in susceptibles than they do in immunes. These organisms generally, but not necessarily, perform their work under plaques which are little understood. These plaques seem to be a gelatinous substance formed by the micro-organisms themselves in their action upon the food taken into the mouth, or by a precipitation of some of the ingredients of the saliva or mucus, and their sole function is to act as protection to the micro-organisms in preventing their displacement by friction, or dilution and neutralization by the saliva of the acids they form. Thus, the acid is held in constant contact with the enamel surface until the calcium salts are dissolved. All plaques on the teeth are not alike; some do not seem to harbor decay micro-organisms, or, at least, decay does not progress in some mouths where the teeth are literally covered with a gelatinous covering.

The micro-organisms of caries produce acetic acid by their action upon carbohydrates in the food. The amount of available carbohydrates thus becomes a factor in the process. Many writers and investigators have advanced the theory that the saliva contained sufficient fermentable carbohydrates to be worthy of consideration, but recent investigations do not attach any material importance to this. The main source of carbohydrates available for fermentation is the food remaining on the teeth and other parts of the mouth after eating. The quality of the food, then, is an important factor in the process. Those eating little or no carbohydrates are free from decay, which is clinically true of meat-eating tribes.

A more important factor than this is the amount of available food left on the teeth after eating. This may be influenced by various conditions of the teeth; such as their regularity and their perfectness which enable the possessor to chew his food properly, thereby rendering it more soluble, and thus mechanically cleanse the teeth. It may also depend upon the thoroughness of the cleansing of the mouth after eating. This, therefore, indicates that the saliva is an important factor. Some salivas are viscous and ropy. Where this form of saliva exists, it is very difficult to keep the teeth clean, because it retains the food, and such conditions are favorable to gelatinous plaques.

*Read before the Indiana State Dental Association, May, 1916. Reproduced by courtesy of *The Dental Summary*.

The acidity or alkalinity of the saliva or mouth fluids as a whole is worthy of consideration, but should not be over-estimated. The pure saliva is normally slightly alkaline, while the reaction of the mucus is normally acid, and quite often so much so that the mouth fluid, as a whole, is slightly acid. However, the acidity of the secretions of the mouth, unless excessive, bears no material relation to caries. Nor does alkalinity bear much relation to the neutralizing effect upon the acid formed by micro-organisms, inasmuch as they have their film or plaque protecting them. This phase of the subject is much over-estimated. We have immunity and susceptibility in both acid and alkaline salivas.

This indicates that the character of the saliva favoring the formation of plaques is worthy of consideration.

One of the most important constituents of the saliva is ptyalin. Its relation to immunity and susceptibility is differently interpreted by various investigators. Some contend that, by its converting starches into sugars, they are readily washed away, thus reducing the possibility of fermentation. Others contend that it forms lactic acid, thus becoming the direct cause of caries. This latter theory is, however, disputed by most investigators. The greater the quantity of ptyalin, the quicker the conversion of starches to sugars, which, being soluble, are more readily washed away, leaving less to ferment. The process of converting starch to sugar is somewhat complicated, but it is of such importance that a brief explanation is necessary.

A starch granule consists of a wall of cellulose and its contents of granulose. When the starch is cooked, the granulose swells and bursts the cellulose wall, the whole mass becoming a paste known as gelatinous starch, which is insoluble. The ptyalin first converts this into a soluble starch, then into dextrins and maltose.

The physical quality of dextrin is sticky, which likely aids in forming plaques. The maltose is readily soluble and easily washed away, especially by the thinner salivas. The thinner salivas are also more active in that they more readily digest the starches and render them easily washed away. The maltose is not washed away, and is easily fermented by the micro-organisms.

We are all familiar with patients who never use any prophylactic measures, but whose saliva seems to literally dissolve all the food around the teeth shortly after eating.

Again, we have all noted cases where the mouth was always apparently clean without the patients making any special pretense at cleansing their teeth. Yet they were susceptible to caries, which fact seems to contradict the assertion that, when the saliva contains the digestive enzymes in sufficient quantities to dissolve the food that remains in the mouth after a meal, the teeth are free from fermentable materials and are immune to decay.

Again, we recall many mouths displaying gelatinous material in great quantities all over the teeth. This gelatinous material is certainly rich in organic matter and is, without doubt, an ideal culture media for all forms of micro-organisms; but in spite of it all, mouths in such condition have been found to be comparatively free from caries.

These various conditions lead us to believe that there is yet some control other than any we have reviewed, which renders the mouth immune even in the presence of rich, fermentable substance, and susceptible even in the presence of a good digestive saliva.

The saliva contains some organic principle, supposedly sulphocyanates, in varying quantities. This is demonstrated by a red reaction obtained by adding ferric chlorid to the saliva. This has been suspected by many investigators to be the immunizing principle that renders the mouth immune to caries under all conditions, even though it is rich in culture media. So enthusiastic are some investigators along this line, that they prescribe a sulphocyanate in cases where the saliva does not contain any. However, many competent investigators, after thorough investigation, dispute the potency of the principle. The chemical tests to determine the presence of these organic constituents are somewhat difficult to understand, unless one is quite well acquainted with the technic of organic laboratory practice. I shall not discuss the experiments here, but suffice it to say that the theory which declares the cyanates responsible for immunity is very questionable.

In the study of susceptibility and immunity to body disease, we are naturally confronted with the study of the sozins which are the defensive proteids occurring in the body. They destroy the bacteria themselves or counteract the toxins which they form, thus causing immunity, and, in case of the absence of these sozins, the body becomes susceptible to the disease. It has been advocated at various times that the saliva or mucus of the mouth might contain such sozins that are predominating factors in the control of caries. There has been but little investigation about this theory and not much data for what has been done and the trend of opinion does not seem to give much credit to the theory. At least, we know that in the mouths of susceptibles and immunes, there are found constantly a dozen or more varieties of micro-organisms which might belie the theory of there being any mycosozins to destroy the bacteria themselves. We also note that there are well-defined plaques in the mouths of both immunes and susceptibles that would be a protecting factor against toxosozins in their effort to neutralize the toxins formed by the bacteria. Yet it is well known that susceptible periods follow pretty closely the stress periods of life, and it is very reasonable to suppose that, during stress periods, there would be a diminution of sozins. This factor, if it is a factor, is at least good food for thought and further investigation.

Thus far we have considered the factors that lie wholly outside of the tooth itself as being the determining factors in the theory of decay. But the physical character of the tooth itself should be considered as a factor.

About twenty years ago Dr. Black published the results of his studies on hardness and softness of teeth in both susceptibles and immunes. He found that there was but a slight difference in the amount of calcium salts in so-called hard and soft teeth, and that hardness and softness, as a determining factor of caries, was a wrong theory. He concludes the study with the following remark: "The causes of immunity and susceptibility to dental caries would necessarily be found in conditions of the general system, influencing the qualities of the mixed fluids of the mouth by which the teeth are surrounded." In his recent book, "Pathology of the Hard Tissues of the Teeth," he republishes and sustains the results of these studies. This lends support to the theory just discussed on the presence of sozins in the mouth fluids as being the determining factor of caries.

The probability of there being a difference of the porosity of the surface of the enamel is supported by quite a few investigators. However, the theory that the calcium contents of the mouth fluids is the factor causing a change in the enamel surface is more likely. This change may be coincident or directly related to stress periods of life.

The calcium determination in the saliva as worked out by members of the Research Commission of the National Dental Association shows that, in cases of immunity, the calcium content of the saliva is distinctly higher than in the susceptibles. In the examination of maternity hospital patients who were in a stress period of life, the results were variable; but, as a whole, much less than the results from a similar number of patients of the same age but not in the same period. They also noted in these patients that as the pregnancy advanced the calcium content of the saliva decreased.

Another experiment that this commission performed to show the effect which a high calcium saliva has on the changes in the enamel surface is interesting in this connection. Following is a brief review: Teeth were sectioned. One half was kept as control while the other was subjected to a high calcium saliva, which was frequently changed each day for thirty days; at the end of that time, all the teeth were subjected to a 10 per cent silver nitrate solution in a reduced atmospheric pressure. The specimens were then subjected to direct sunlight and microscopic sections made. It was found that the silver nitrate had penetrated much deeper in the controls than in those subjected to the high calcium saliva.

In view of the above data and experiments, it would seem quite probable that, during periods of immunity, the saliva is high in calcium contents which would render the enamel surface more compact, thus increasing its acid resistance and reducing the clinging qualities of the plaques; and *vice versa* during periods of susceptibility.

After considering the various conditions entering into the theory of decay, I am led to the conclusion that there is no single condition which determines susceptibility and immunity in dental caries.

While not within the scope of this paper, still we should discuss briefly the formation of the cavity. The initial lesion of a cavity in the crown of a tooth always begins on the enamel surface. The micro-organisms grow upon the surface, where they form the acid which dissolves the cementing substance and rods of the enamel, the former dissolving faster. The micro-organisms never enter the structure until a portion of the enamel rod falls out. The lactic acid attacks the calcium salts, forming calcium lactate. This dissolution precedes the falling out of the tooth structure and operates according to the laws of osmosis in the deeper layers. This falling out of the tooth structure always precedes the entrance of micro-organisms. In caries of dentin, the same agencies operate in the same manner as they do in the enamel. As soon as micro-organisms enter the dentin they operate within the dentinal tubules. They secure their sugar by osmosis, forming lactic acid, which, in turn, forms the double salt, calcium lactate, which finds its way out by osmosis. The organic matrix of the dentin finally is digested by the enzymes of the facultative anaerobic micro-organisms operating within the matrix, using it as a culture medium. This whole process, however, may stop at any stage of the cavity formation, if a period of immunity arise in the individual, and later start again, if a period of susceptibility arises.

DISCUSSION.

W. R. Meeker, Peru: In looking over this paper the first thought brought to my mind was that caries has been treated more as a mechanical condition to be dealt with, than as the result of a chemical action to be controlled.

When I replied to Dr. Carr, telling him that I would discuss Dr. Brooks' paper on "Susceptibility to and Immunity from Caries," I had no idea what direction the doctor would take; and this is only one illustration of the second clause of his paper, where the essayist quotes Dr. Black in making a plea that we do not divorce our dental practice from the study of the pathology of dental caries. How often our patients come to us for relief and we see only the repair work to be done and overlook all thought of the future or that we have any responsibility with reference to their future. The doctor's paper has opened a new phase of an old subject.

In the first part of the paper only once does the essayist refer to the physical condition of the teeth as having any relation to "Susceptibility to and Immunity from Caries," and then only as the possessor may be able to chew his food properly, thereby rendering it more soluble and thus mechanically cleansing the teeth. In thus divorcing the physical condition of the teeth from all consideration of the subject I feel we overlook an explanation of many conditions ascribed to the influence of the saliva upon the teeth.

In those cases coming to my notice I have noted that in nearly, if not all cases of those immune from caries, the teeth are very nearly perfect, physically. I had a case just recently, in fact since the essayist's paper was placed in my hands, which came to me for services as the result of an accident. The man, who was past fifty years of age, informed me that it was his first visit to a dentist and that he had never owned a tooth brush. (In fact, he told me he thought three-fourths of the trouble with people's teeth to-day came from the use of the tooth brush and the work of the dentists.) In looking over this case, I found the teeth nearly perfect, the union of all developmental lobes complete, enamel very hard and very regular, showing the wear of years of service, but free from caries, one of those cases of "immunity" which if we could but reproduce would make us far more useful to humanity than the mere replacing of broken-down tooth structure.

I found it necessary to extract two of the anterior teeth, and, having in mind the thought of what could produce such perfect teeth after these years of service, I decided to place one of them in a weak solution of lactic acid, along with a freshly extracted tooth from the mouth of what we would term a susceptible, and I found that the tooth from the mouth of the immune resisted the action of the acid far more than the tooth from the mouth of the susceptible. I cannot recall seeing a case where this immunity exists that the teeth were defective, and, while we do see apparently perfect teeth that are very susceptible to caries, those cases where immunity does exist are found in mouths with very good teeth.

Dr. Black in his work on "Dental Caries," while maintaining that "physical imperfections are in no wise a cause of dental caries," states "they give greater opportunity for the active agents of caries to work."

In speaking of the plaques under which the ferments work and by which they are protected, the essayist says: "They are little understood." This seems to be the last word of all investigators, not only as regards the plaques but as regards the whole chemical composition of the saliva. It is a well-known fact that saliva varies both as to the amount and to the alkalinity. The sight of a lemon being squeezed will produce an abundant flow of saliva of a much stronger alkalinity than common. Pain produces an abundant flow of saliva, but it is mostly water and of a very low alkalinity. It has been said that the beginning and ending of each meal with an acid fruit will increase the alkalinity of the saliva. In the later years of Dr. Miller's life, he remarked that although he could explain how dental caries occurred, he could not explain why.

The plaque theory is credited by most investigators, but there are those who differ, calling attention to the fact that free lactic acid will destroy the bacteria that produces fermentation, and that it would be necessary that all acid be at once neutralized at the expense of the inorganic portion of the tooth structure, calcium lactate being formed to permit a continuation of the fermentation. Marshall calls attention to the fact that these plaques occur on all surfaces of the teeth and not alone on the mesio and distal surfaces, which are most liable to attack by caries, and that the saliva which almost immediately permeates all food upon mastication contains countless millions of organisms capable of transforming carbohydrates into acid; that bacteria plaques upon the teeth are not an essential factor in the cause of decay, but that the lodgment and infection of carbohydrate material is the essential factor and that any circumstance which favors the lodgment of carbohydrates favors the development of caries.

In speaking of the amount of available carbohydrates becoming a factor in the process of decay, the essayist states: "Those eating little or no carbohydrates are free from decay, which is true of meat-eating tribes." While this is, in the main, no doubt, the cause of the immunity, we may look for a part of it to the physical condition of the teeth, the method of the preparation of the food and to the method of eating it, all of which tend to mechanically cleanse the teeth, thereby making them less susceptible to caries.

The action of the saliva on the teeth is as yet a closed book. That it does have the ability in certain cases to make teeth immune from caries seems proven beyond a doubt, but just how and why we have not been told.

Dr. Head, in reporting some of his experiments, called attention several years ago to the fact that he had reproduced the hardness of enamel that had been destroyed by the action of weak lactic acid, by immersing the weakened tooth in saliva (living saliva as he called it). He called attention to the fact that 1 to 1,000 lactic acid and water at mouth temperature would cut tooth enamel in thirty minutes to a rough white surface, while a 1 to 500 lactic acid solution and some saliva would not affect it.

The report of the Research Commission of the National Dental Association on hardening of enamel by the action of certain salivas on it, as reported by the essayist, is a verification of the results attained by Dr. Head several years ago, when he subjected a tooth to a weak lactic acid solution until it could be cut with a lancet; then by immersing it in living saliva he could bring it back to its original hardness.

That Dr. Head's investigations were carried on very accurately may be realized from the sensitiveness of the machine he used, he being able to tell to 1/600,000 of an inch the depth of a punch of a certain size entering the enamel under pressure. In speaking of the changes that occur to enamel of a tooth, under changed conditions, he said: "I cannot explain how these changes occur, because I do not know. I am simply in a maze of astonishment."

To me the cause and progress of decay are influenced by a large variety of factors: the character and number of organisms present, the amount of carbohydrate material available for acid production, the amount of alkalinity of the saliva, the resistance of the enamel, both as to structural strength and arrangement of the teeth.

No doubt with the present research work that is being done on this subject, we will, in the near future, be told whether caries is of local or systemic origin.

Wolf's Comet (1916 *b*)

WHEN we received the announcement of the discovery of this comet on May 1st there was much uncertainty as to its nature and one was in doubt what to look for. It was possibly an asteroid. A photograph of this region with the Bruce 10-inch lens on April 24th, 1916, showed a trail near the place. This, however, proved not to be Wolf's object, but the asteroid *Aeternitas* (446); see *A. N.*, 4845. When it was located by a photograph taken with the two-foot reflector by Mr. E. P. Hubble, to whom I am greatly indebted, its cometary nature was at once evident. A closer inspection then showed it on the photograph of April 24th, where its position was measured with respect to a faint star close to it, which was subsequently accurately measured in the sky. On the photograph the comet was excessively faint and could only be found by knowing closely where it should be.

Visually, in the large telescope, the object was always cometary, though it was very small. Under good conditions it was in no wise a difficult or faint object, as the notes that follow will show. It is probable that the comet will become a naked eye object in June of 1917.

NOTES ON THE APPEARANCE OF THE COMET.

May 6. Round, not very diffused. A tiny nucleus of 16th magnitude north preceding the center. Measured diameter of the comet, 3".7. At 12 hours 30 minutes it was quite conspicuous and about 12½ magnitude.

May 10. The comet was very faint from moonlight and haze.

May 22. It was 13½ magnitude, with a star-like nucleus of 14 or 14½ magnitude north preceding the center. Measured diameter = 11".1.

May 27. It was 13½ or 14 magnitude, round, with a faint nucleus in the north preceding part.

June 3. Excessively difficult in clouds. Position of comparison star not determined. A fainter star preceding the comet 1'—2'.

June 17. Faint in bad sky.

June 21. Very faint in clouds.

June 24. Faint on a bright sky. It was 14th magnitude, with a faint star-like nucleus.

June 28. The comet was 10" ± in diameter and seemed to brush out south. With a magnifying power of 700 diameters it was a little better seen. It was 14½ magnitude, with possibly a faint nucleus. Sky thick.

July 1. Very small and faint. Better seen during the second set of measures.

July 5. Very small; 14 or 15 magnitude.

July 8. Excessively difficult and uncertain from moonlight and bad seeing, especially at the measures for right ascension.

The comet could have been followed longer but for the cloudy and bad western skies.—*Prof. E. E. Barnard, Yerkes Observatory, Williams Bay, Wisconsin, in the Astronomical Journal.*

The Pottery Tree

AMONG the many products of the vegetable kingdom few are more important than barks, both for medicinal and technical purposes. While the structure and formation of all barks are essentially very similar in many respects, the bark of the so-called pottery tree of Brazil deserves special mention, because it is a remarkable example of the hardest bark known. This tree is known to the Spaniards as *el cauta*, to the French as *bois de fer*, and to the Brazilians as *caripe verdadeira* or *cariperana*. Botanists have adopted the name *Moquilea utilis* for this important tree which is, in its mature state, exceedingly large, straight and slender, often attaining a height of one hundred feet to the first branches.

After the wood is thoroughly seasoned it becomes so hard that ordinary tools will not cut it. It contains a good deal of tannin and is often used for this purpose in the green state. Although the wood is of great value, the chief importance of this tree lies in the fact that the natives of Brazil use the bark largely as a source of silica in the manufacture of pottery. When the bark is still green it cuts like soft sandstone and the presence of the numerous gritty particles (crystals of calcium oxalate) may be ascertained by chewing small pieces of the inner bark. After it is dry it is too hard to crush it between the teeth; it becomes brittle upon seasoning and usually so hard that it cannot be cut with an ax or machete. When bark of good quality is burned it cannot be broken up between the fingers, but a pestle and mortar are required to crush it.

In the manufacture of pottery the natives of Brazil always use the ashes of the bark reduced to a fine powder, and mix it with an equal amount of the purest clay obtainable from the riverbeds. The Indians collect the bark, season it thoroughly and then burn it. The ash of the dry bark remains intact and in this form can be gathered more easily and stored than in powdered or semi-powdered state. These ashes are used in the manufacture of nearly all kinds of utensils that are required to stand great heat.

Photograph from the American Museum of Natural History *Photo by E. W. Deming*

Tablet Dance, twenty-two years ago, at Santo Domingo.

Photograph from the American Museum of Natural History *Photo by H. J. Spinden.*

Costumes of Tablet Dance at San Ildefonso.

Indian Dances of the Southwest*

Ceremonies Symbolic of Events of Daily Life

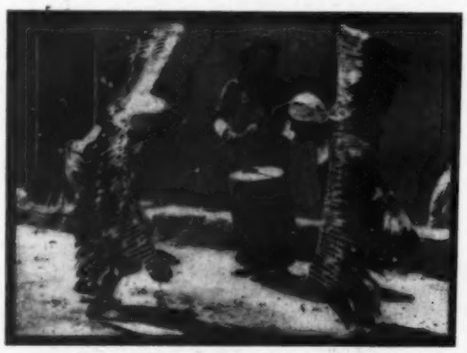
By Herbert J. Spinden

THE numerous dances of the Pueblo Indians are never entirely free from a religious idea. Some are so deeply religious that they are jealously guarded from all profane eyes and are held at night in underground lodges. The War Captain's men keep watch at every road so that no outsider can glimpse the masked dancers impersonating gods. Even in the underground lodges the faces of the uninitiated children are covered while the dance is in progress so that they may hear but not see. This secretiveness is most developed in the villages along the Rio Grande, in New Mexico, where the native religion has encountered the opposition of the Catholic Church for nearly 400 years. Other dances are held in the plaza of the village, and here visitors are usually tolerated, while on the annual feast day of each pueblo they are welcomed to a more or less innocuous entertainment.

The characteristic dances of the Pueblo Indians are strikingly different from those wild gyrations that we associate with the nomadic and warlike Plains Indians. There are, to be sure, a number of such dances—Enemy Dances they are called—that have been taken bodily from this or that wild tribe and are known by the tribe's name, such as the Cheyenne Dance, the Pawnee Dance, the Navajo Dance. These foreign dances are mostly concerned with war and are not regarded as having any important religious character. Yet it is significant that title to use them was obtained by purchase or trade before the dances were included in the village repertory. Of course the foreign songs had to be learned by rote and a special set of costumes made in keeping with the place of origin.

In one of the introduced dances that is popular at Taos—a woman's dance and therefore not gymnastic—there is first, in the center, a chorus of men. Some of these sit around a large drum, which they beat in unison, while others kneel and mark time by scraping notched sticks that rest on a log for a sounding board. Around them in a circle, or half-circle, are dancing girls. These are not in their everyday Pueblo attire of woven blanket dress with colored belt and whitened deerskin boots, but in the fringed deerskin dress of their Plains-bred sisters, with moccasins and leggings. Scarcely lifting their feet from the ground, as they keep time to the song and the throbbing rhythm of the drum and the notched stick instruments, the girls move slowly round the circle, using their two hands in a graceful warding-off motion. Outside the circle of girls is a larger circle of men in blankets, each resting his right arm across the shoulder of the man in front and all moving in a direction opposite to that taken by the girl dancers. These men represent Pueblo Indian visitors at the camp of the Plains Indians. The girl dancers and the inner chorus of men are the hosts who provide the entertainment. We see in this the dramatic instinct which in many Pueblo ceremonies is developed to a high degree. The famous Snake Dance of the Hopi is a partial dramatization of an important myth.

Photograph from the American Museum of Natural History



Photograph from the American Museum of Natural History

Photograph from the American Museum of Natural History

The Eagle Dance is exhausting physically to the dancers, but interesting to the spectators for its dramatic quality. The eagle men are guided from the underground lodge to the dancing place by a line of sprinkled corn. They imitate very cleverly the characteristic postures of a bird.

While the steps in many Indian dances are simple in the extreme, there is a delicate pulsing rhythm that affects the whole body and makes the dance almost impossible of imitation for one of another race. Dances in which both men and women appear are perhaps more common among Pueblo Indians than elsewhere in North America. There is rarely the slightest body contact between dancers of different sexes and never an embrace such as characterizes our own dances of pleasure. Pueblo dances are conducted decorously—if we omit the religious orders of clowns whose antics are often none too delicate. Both men and women seem to be imbued with a sense of religious solemnity and seldom smile, but there is no doubt that the sway of the dance is no less a source of sensuous delight to them than it is to ourselves.

Pueblo dances proper are mostly concerned with rain, fruitful harvests, and abundant supplies of game. Much of the prescribed regalia represents clouds, falling water and blossoming plants. The symbolism is worked out in feather headdresses, embroidered aprons, painted wands, etc., and is magical or coercive in character. Wild animals are supposed to be pleased by dances in which they are mimicked and to allow themselves to be killed in return. All the persons chosen for important dances have to undergo four days of preparation and purification, during which they are isolated from their townsfolk. The religious heads of the village, called "caciques," are masters of ceremonies and the War Captain and his men are watchers, warders and providers.

The public dances in the plaza are more or less processional, but the advance is very slow and the trail of footprints in the dust shows how the dancers have inched their way. There are definite spots for stationary dancing and here countermarching is used to make new quadrille-like formations.

A good example of this sort of dance is the so-called Tablita Dance, which takes its name from a painted tablet representing clouds that is worn on the heads of the women. It is a spring and summer dance connected with maize and is designed to bring rain for the growing crops. The costume is especially devised for this occasion and every detail of dress and ornament has a special import. Of course, variations are to be noted from one pueblo to another. On the great feast day of Santo Domingo in August this dance is celebrated and several hundred persons take part in it. Besides the men and women dancers, who are divided into two divisions according to the social grouping of the clans, there are Chiffonetti or Delight-takers in two orders and a number of individuals painted to represent

*Courtesy of *The American Museum Journal*.

pecial mythological beings. The Chiffonetti are clowns whose naked bodies are painted with broad stripes of black and white and whose hair is smeared with mud and tied with corn husk. The ostensible purpose of these clowns is to make merry and do what mischief they can, but in reality they are the only persons who can conduct the gods of rain and fruitfulness into the village and they thus occupy an important esoteric place in Pueblo religious life.

The Buffalo Dance, the Deer Dance and the Eagle Dance are examples of mimic animal dances. Headdress and body coverings are made when possible from the skins of the animals in question or color is used where skins cannot be worn. The characteristic cries and postures of the animals are often cleverly imitated. In the Buffalo Dance a number of animals, including deer, antelope and elk, are represented in addition to the Buffalo Men and the Buffalo Maid. Except in case of the last-mentioned person, all the dancers wear animal headdresses. They are brought into the village at daybreak by herders dressed in buffalo robes and carrying bows and arrows. A chorus meets them and escorts them, between a double file of ordinary men and women dancers, to the dancing places. The dance lasts about twenty minutes and is repeated several times during the day. At sunset the dancers retire into the hills and resume their ordinary clothing. In the Deer Dance the same mimicry is seen, and when the last dance is over the deer run away into the hills at top speed. The girls try to catch one of the little deer and sometimes succeed.

At the secret dances held at night in the underground lodges the dancers wear masks and impersonate the mythological beings. Most of these have definite and well-known characteristics and are at once recognized. Although dances of this sort in the Rio Grande region cannot be seen by outsiders and must be studied from information and native drawings, still similar ones are danced in the open in the Hopi villages of Arizona. The dramatic instinct comes out strongly in some of these secret dances. This is particularly true of the ceremonies preceding the arrival of the masked dancers who represent mythological beings. These mythological beings are supposed to live in the under world and to come up through lakes and springs when they visit the upper world. The Chiffonetti or clowns are the intermediaries between mortals and these gods.

The caciques determine when a masked dance is to be held and they select the dancers. The latter are locked up for four days and purified by fasting and ablution. At the appointed time all the villagers go to the underground lodge and seat themselves in readiness for the performance. Soon two clowns appear at the hatchway in the roof and come down the ladder. They make merry with the spectators. Then one says to the other, "My brother, from what lake shall we get our masked dancers to-night?" "Oh, I don't know. Let's try Dawn Cañon Lake. Maybe some Cloud People are stopping there." Then one clown takes some ashes from the fireplace and blows it out in front of him "Look, brother," he says, "do you see any Cloud People?" They peer across the ash cloud and one says, "Yes, here they come now. They are walking on the cloud. Now they stop at Cottonwood Leaf Lake." Then the other clown blows ashes and the questions are repeated. Thus the Cloud People are drawn nearer and nearer until they enter the village. The clowns become more and more excited and finally cry: "Here they are now!" and the masked dancers stamp on the roof and throw game, fruit and cakes down the hatchway.

When the masked dancers enter, the children are covered but the older people drink in the divine presence with the palm of their hands as one scoops up and drinks water. These masked dancers may not talk, although they make peculiar sounds. Their wishes are told in pantomime.

The songs used in these ultra-sacred ceremonies have words and sometimes a sentiment that is beautiful. More commonplace dances may be accompanied by songs without real words and only a jumble of meaningless syllables. Here is a song from the Turtle Dance—one of the winter dances of sacred type. It refers to the coming of spring.

Povi ts'e anyu	Yellow Flower Girl!
Povi tsâ nyu anyu	Blue Flower Girl!
Khuª p'i nyu anyu	Mottled Corn Girl!
Khuª tsâ nyu anyu	Blue Corn Girl!
Gi naªᶻ ak'o	Thus on the plain,
Gi naªᶻ ak'o	Thus on the plain,
Nde wa pa he raªᶻ	Everything they revive
Na we ndi powa	And hither return!

Photograph from the American Museum of Natural History Photo by E. W. Deming

Side dancer in Buffalo Dance.

Photograph from the American Museum of Natural History Photo by E. W. Deming

Buffalo Dance 22 years ago.

Photograph from the American Museum of Natural History Photo by E. W. Deming

The Tablet Dance is a prayer for rain.

Milan-Venice Canal

An extensive project for a canal system to connect Milan with the sea has already been worked out by Italian engineers and it is intended to put it into execution after the war. The complete project for canals and ports is already adopted at Milan by the municipality and the Chamber of Commerce. According to G. Fumigalli, a prominent engineer, the canal system consists of three distinct parts, first a canal from Milan to the Po River of 45 miles length, then the river itself serves as a waterway for some 160 miles, after which a 30-mile canal leads from the river to Venice. The first portion of the system uses the river Adda, which is canalized upon a certain length, while in the last section, existing canals are employed which connect to the lagoon at Venice. Milan is to have an extensive port with three basins, including two for commerce and one for industry, and the city has already purchased ground near the city for the purpose. Basins are 200 feet wide and 2,500 feet long. Canal traffic is expected to reach 1,500,000 tons a year at least, the greater part being in the shape of coal and ores, and the remainder mostly materials of construction.

Photograph from the American Museum of Natural History Photo by E. W. Deming 1920

Buffalo Dance at San Ildefonso.

Photograph from the American Museum of Natural History Photo by E. W. Deming

Chanters in the Tablet Dance, Santo Domingo.

Obstacles to Success in Engineering

Difficulties Encountered by Engineers and Contractors, and Advice to Young Engineers

By Sir Maurice FitzMaurice, C.M.G., M.A., M.A.L., LL.D., President of the Institution of Civil Engineers

In his address, delivered on the occasion of his installation as president of the Institution of Civil Engineers, Sir Maurice FitzMaurice dealt with some of the reasons which prevent success in the profession.

The necessity for alteration of design, or part of design, owing to unforeseen difficulties, is generally a matter which causes much anxious thought and trouble to engineer and client. Unfortunately, alteration in design is generally accompanied by increased cost and time. In exceptional cases unforeseen difficulties may necessitate abandonment of the work. The question arises, Are engineers, as a rule, too optimistic in designing their work and in their estimates of time and cost? This question, however, only deals partially with the class of failures I am considering, and before going further I want to clear the ground in connection with one important point.

CONTRACT DIFFICULTIES.

As is well known, there are two ways of obtaining contractors for works, either by open tender or by asking selected firms to tender. It might be considered that all difficulties could be avoided by asking selected firms to tender, and in such cases it is generally understood that the lowest tender will be accepted. The procedure is, however, often not satisfactory. It frequently happens that the client wishes to include in the selected list the name of a firm who has carried out to his knowledge some work in a satisfactory way, although of quite a different character to that being dealt with at the time. This is often the cause of great trouble to client, engineer and contractor.

We all know contractors whom we would cheerfully accept without any question of reference—firms who at an early stage of the work recognize the necessity of a good staff and of providing all necessary plant, and who know that the initial cost thereby incurred is more than regained by the facilities obtained in carrying out the work and by the saving resulting from curtailment in time of construction. It is probably due to the well-deserved profits made by such contractors that other firms without the necessary capital or experience are frequently tempted to tender for work which they are not capable of carrying out with satisfaction to the engineer or his client, or with profit to themselves.

It must not, however, be assumed that I am favoring in all cases the employment of the large contractors. I have had considerable experience with contractors in quite a small way of business who carry out the smaller contracts entrusted to them in a thoroughly satisfactory way, especially when they have laid themselves out for only one or two classes of work, when the principal can give personal attention to the matter, and when they resist the temptation to embark on undertakings beyond their capacity. Some of my most pleasant experiences in engineering work have been with such firms.

ARE ENGINEERS TOO OPTIMISTIC?

I now come to the question whether engineers, as a rule, are too optimistic in designing their work, and in their estimates of cost and time. On full consideration of the matter, I am inclined to think that we must sometimes plead guilty to this charge, although the optimistic view and under-estimates of cost and time are not always willingly arrived at. I do not know whether my experience on this point is the same as that of other engineers.

I am well aware that even in works where all the details have been worked out with the greatest care, where unit prices have been carefully scrutinized, where the different stages of the work have been well thought out, where all possible local information has been obtained, that even then it is necessary to provide a sum of money over and above the detailed estimate to meet any contingencies which may arise, and to make some addition to the estimated time for construction.

What, shortly, are the principal matters which cause us trouble? The first one, in my opinion, is the small knowledge we are able to obtain of the conditions that exist below the surface of the earth, on which everything has to be founded; secondly, the risk which it is necessary to undertake as regards conditions of weather while works are being carried out; and thirdly, the varying quality of many of the materials we have to deal with. There is a fourth matter, which affects contractors more than engineers—namely, the difficulty of estimating the cost of materials and rates of wages for a long time ahead. This last also substantially affects engineers' estimates when there is a long interval between the time when the estimates are made and that when the tenders are received.

BORINGS AND WHAT THEY WILL TELL.

As regards the first of these matters, we in most cases try to obtain all information possible about the nature of the ground we have to deal with by making borings. It is commonplace to remark that the information obtained from borings is not always reliable, particularly when the ground is of variable character. It is true that, with certain classes of boring machinery, particularly when in rock, we can obtain cores which give information of great value. In many cases, however, it is very difficult to form a just estimate of the ground when the material has to be broken up by the ordinary drill before being brought to the surface. After all information has been obtained by borings, the fact remains that all we have is a rough idea of the nature of the ground at the exact spot where the boring has been made. In many cases, if one goes fifty feet north, south, east or west, very different information is obtained. . . .

Such cases could be multiplied at will, and it is quite obvious that borings cannot be made at such close intervals as will disclose, as far as borings can, the nature of all the ground which has to be dealt with.

THE WAR OF THE ELEMENTS.

There are other causes which prevent engineers from obtaining exact results, and the war of the elements is very real to them. Many an engineer who has been carrying out harbor works stands helpless and dismayed on his works when an exceptionally heavy storm comes at a specially critical stage of construction, and when the work of months may have vanished in a few hours.

It is not, however, only unfinished works which suffer. We can probably all bring to mind finished works of the same class which have stood for years and have eventually been overcome by storms of exceptional fury. In some cases failures of such completed works are not due to any initial mistake in design, but owing to the fact that the inevitable ravages of storms for many years have not been dealt with as they occur, and that in fact maintenance works have been conspicuous by their absence.

Of course, harbor works are not the only ones which have to lament the occurrence of exceptional storms during construction. They often cause considerable damage to incompleted steelwork, such as bridges and roofs, and in fact they take their toll from time to time from all works. . . . In some countries, where exceptional cold is experienced, the after effects of continuous frosts have to be fully allowed for in engineering works, both in estimates of cost and time.

There are other matters affecting not only the estimates of cost and time, but also the utility of engineering works, which are due to the impossibility of being able to arrive at exact conclusions on many points which arise.

There is, again the perennial question of the *actual* stresses occurring in masonry dams. Some time ago this question was fully debated before the Institution, and many experiments in connection therewith on many materials, except masonry and concrete, have been made. We still, however, know very little more than that certain dams designed on certain definite lines have been successful and that others have failed.

We may, again, consider the question of the improvement of rivers, and the many intricate questions which arise in connection therewith. As one of the members of this Institution has very wisely stated, it is necessary for one to live for years with a river before all its idiosyncrasies can be mastered. It is, no doubt, comparatively easy to come to a conclusion of some matters which may obviously require to be dealt with, but dealing with an important river as a whole on a large scale probably requires more experience, study, and careful survey of all the natural features than any other work which an engineer has to deal with.

A cause of occasional failure in temporary work is due to the fact that engineers and contractors sometimes take deliberate and justifiable risks in connection with such works. . . . In many cases of temporary works risks are taken deliberately; the cost of reconstructing such temporary works, should failure occur, might only be a small portion of the cost involved if the works were constructed in a more solid manner, and in such cases the risk is fully justified.

ENGINEERING NOT AN EXACT SCIENCE.

Perhaps I have said enough in this rather melancholy recital of some of the difficulties which engineers have to contend with, to show that the common saying that engineering is not an exact science hardly goes far enough to show how inexact a science it is. Although much of the work of an engineer is based on strictly scientific procedure, it is to a great extent dependent on experiment, experience, and a proper appreciation and balancing of the inexact knowledge available.

RESEARCH WORK.

It is difficult to make any suggestions to facilitate our work; but it has occurred to me on more than one occasion that our brother engineers on the other side of the Atlantic devote more time than we do to preliminary work and studies, particularly in the case of large undertakings. They appear in some cases to have taught their clients that time and money spent on very full investigation and preliminary studies gives a very good return on the expenditure. The governments of Canada and the United States are also not averse to collecting information about rainfall, river discharges, and other matters, which information is at the disposal of those who wish to avail themselves of it. If we could prevail on our clients and on our Government to take similar views, they would also find that the money was not wasted. We are, however, as things stand, dependent to a great extent on experience and private investigation and experiment for the success of many of our works. We ought not, at the same time, to forget the great obligations which we engineers are frequently under to chemists, geologists, metallurgists, meteorologists, and others, for the great help which they ungrudgingly give us.

I hope, however, that the Government "Scheme for the Organization and Development of Scientific and Industrial Research," which has recently come into existence, and which has already made a grant to this Institution for research work, may be a real help to engineers. The scheme in its main features is one conceived on broad and patriotic lines, which may lead to results even greater than were anticipated by those who framed it. As far as I know, the detailed arrangements under which it will be administered have not as yet been definitely laid down. Some, but not all, of the industries which may expect help are at the present time so engaged with war work that it is not possible for those controlling them to fully consider, much less to carry out, useful research work. Such work, to be of real value, must be undertaken in consultation with the different industries. It is, however, important that some definite lines for the working of the Government scheme should be laid down at an early date. I hope and believe that it may be developed on such broad, liberal, and generous lines as will command confidence. If worked on such lines the scheme will be of great value. "A great empire and little minds go ill together."

WANT OF SUCCESS IN INDIVIDUALS.

The time will come when we must settle down again to our every-day duties, and, therefore, I venture to say a few words on the question of want of success in individuals. All of us, no doubt, on many occasions during our lives have made mistakes which, with a little reflection, might have been avoided. We have often bought our experience dearly. We probably realize that in some cases there was very little margin between success and failure. In looking back, however, over the great number of engineers whom I have come across on works and in offices, I cannot bring to mind any case of a hard worker who has really failed. It is true that all of them have not arrived at commanding and independent positions, but then all men have not the ambition, or wish, or capacity for such positions. The attainment of such a place might possibly mean failure for some of them, and they prefer to retain the confidence and respect of their employers in the secondary posts, and in doing so they probably have a less anxious and a happier life. I know of some engineers who have not attained to high positions, but who could be sent to take charge of works, with the knowledge that every stage of the work will be carefully and continuously inspected by them, and that if any difficulties arise they will recognize them, and at once report to

*From the *English Mechanic and World of Science.*

ir chief fully and clearly about them. Such men are aluable. There are, however, also a great number engineers who begin their professional work with hope and determination of getting to the top rung the ladder, or, at all events, making a good fight it. . . .

consider that there has been in recent years some provement in general education, which tends to give able boys the chance of taking up the profession of gineering when they have an inclination in that ection. Very much more, however, might be done in s connection. . . . While I need hardly say that m extremely keen about a radical alteration in our aching, so that scientific education may be kept all time in the foreground, I do not wish to see young n growing up without what, in an old-fashioned way, uld be called a good general education. We at this stitution have been altering our examinations and ctical requirements from time to time so as to raise scientific standard required for students and asso- te members, but we have not forgotten the value of ood general education. . . .

ADVICE TO YOUNG ENGINEERS.

I have frequently been asked by parents of budding gineers and by young engineers themselves, for ad- e, and the remarks which I have to make on the ject are specially directed to the students and the y young members of the institution. The examina- ns by the institution, or the corresponding ones at universities, which have now for some time been uired before a young engineer can become an asso- te member of the institution, are, of course, only e groundwork for the work to come later on. Nothing take the place of experience, and actual contact h difficulties. It is, therefore, necessary that an gineer should devote his time to getting all experience ssible.

I remember being told, many years ago, by a friend o had passed through the engineering school at mbridge University, that he asked the professor of gineering at that time for some advice on what he uld do. The answer he got was: "Try and get into me large shops, or onto some large works; if you n't get taken on as an assistant or improver, try and t taken on as an assistant timekeeper." There is mething to be said for that advice.

I have on one or two occasions been asked by a oung engineer whether, of two posts offered to him, should take that of one among many assistants on large work with a small salary, or that of resident gineer on a small unimportant work at a considerably gher salary. Without hesitation I recommended the rmer position. I knew that on the large works he uld see a little of almost every class of work, that en the temporary works of the one were probably ore important than the permanent work of the other, d that the fact of being on a large work would be great assistance later on, and would stand to him l his life. He would also have the advantage of daily tercourse with other engineers, and the emulation and iendly rivalry between them would lead to efforts on s part to hold his own. There also exists on large rks a feeling, which I can only describe as engineer- g atmosphere, which may have a real influence on the fe of a young engineer.

THE WAYS TO SUCCESS.

Experience and the passing of hard engineering ex- minations are, however, not the only requisites for uccess in our profession. I suppose there is no class f engineer more in request than the resident engineer r assistant engineer with experience, who can "get on" ith people. Engineers are afraid of assistants who n't get on with people. Such men irritate clients; ey cause trouble, whether they are on the engineer's r contractor's side. The capacity of getting on with ople and still holding one's own has a distinct money alue, and a very high one.

Closely akin to it is the one of being fair in dealing ith questions which arise on work. The resident gineer and the contractor's engineer who are open ith each other, and will not take any unfair advantage f one another, have both obtained a reputation of eat value, and which may have a far-reaching effect en on both their firms.

In my opinion there is nothing which so much en- rges a young engineer's breadth of view, and gives m a feeling of self-reliance, as a few years' work broad. The ideal conditions in connection with this e that it should be after some years' work at home, d be on work under construction by a British firm; t these ideal conditions are not, of course, always ssible. One can only acquire knowledge of how rks are carried out abroad, and the differences tween such works and those in this country, by tually being engaged on the details of construction. In going abroad, young engineers should be careful, if possible, not to break any engineering connection which may have been formed at home. I personally have always considered it was extremely fortunate that I was employed for seven years on undertakings outside this country. In view of foreign work, it is essential that a young engineer should know well at least one foreign language. This knowledge will often be the deciding factor in gaining an appointment.

All young engineers should take every opportunity of carrying out experimental work. Such opportunities occur on nearly every undertaking. It need not be original work, as that is not always possible, but even the repetition of work previously done gets one interested and accustomed to that class of work, and it may be the means of correcting and enlarging the work done by others. Very frequently the engineer in charge of works or shops sees opportunity for carrying out experimental work with very little money expenditure, but frequently that small amount of money cannot be found. If there were a fund available from which grants could be made in such cases for certain definite experimental work, I consider it would be very valuable, both to the members as a body and to the members carrying out the investigation.

My remarks are really reflections on the different events which have occurred during my own life as an engineer, extending now to over thirty years. I hope they at least show that there is still ample room for investigation and experimental work, which may enable us to give still greater value to our clients, and that it may influence young engineers especially to devote some of their time to that class of work whenever opportunity for doing so is present.

The Essex Zeppelin—Outlines of Zeppelin Design

THE inspection that was permitted last week of the wreckage of the Zeppelin L-33, which descended near the coast of Essex on September 24th, though somewhat cursory, was sufficient to reveal the main outlines of the design as well as to give an idea of the enormous amount of detail involved in the construction. The envelope and the gas bags had disappeared, having been set on fire by the crew when they left the vessel, and the metallic framework was badly damaged, partly by the bombs which they employed and partly, no doubt, by the shock of landing, while portions of the structure had been removed by the authorities.

CONSTRUCTION OF THE BODY.

From 650 feet to 680 feet in length, and measuring 72 feet across its largest diameter, the vessel was of stream-line form, with a blunt rounded nose and a tail that tapered off to a sharp point. The framework was made up of a series of longitudinal lattice-work girders, connected together at intervals by circumferential lattice-work ties, all made of an aluminium alloy resembling duralumin. The whole was braced together and stiffened by a system of wires, arrangements being provided by which they could be tightened up when required. The weight of the framework is reckoned to be about nine tons, or barely a fifth of the total of fifty tons attributed to the airship complete with engines, fuel, guns and crew. There were twenty-four ballonets arranged within the framework, and the hydrogen capacity was 2,000,000 cubic feet.

A cat-walk, an arched passage with a footway nine inches wide, running along the keel, enabled the crew, which consisted of twenty-two men, to move about the ship and get from one gondola to another. This footway was covered with wood, a material which, however, was evidently avoided as much as possible in the construction of the ship. The gondolas, made of aluminium alloy, were four in number; one was placed forward on the center line, two were amidships one on each side, and the fourth was aft, again on the center line.

PROPULSION.

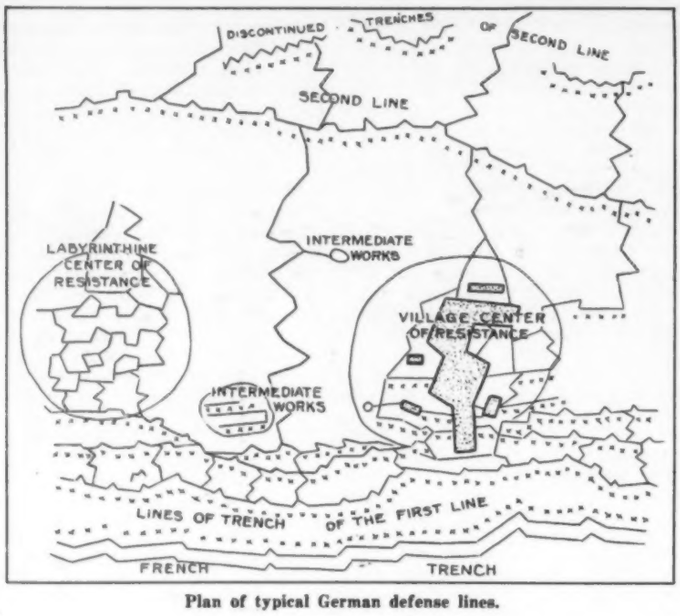
The vessel was propelled—at a speed, it is thought, of about sixty miles an hour in still air—by means of six Maybach-Mercédès gasoline engines of 240 horse-power each, or 1,440 horse-power in all. Each had six vertical cylinders with overhead valves and water cooling, and weighed about 1,000 pounds. They were connected each to a propeller shaft through a clutch and change-speed gear, and also to a dynamo used either for lighting or for furnishing power to the wireless installation. One of these engines with its propeller was placed at the back of the large forward gondola; two were in the amidships gondolas, and three were in the aft gondola. In the last case one of the propellers was in the center line of the ship, and the shafts of the other two were stayed out, one on either side. With the object of minimizing air-resistance the stays were provided with a light but strong casing of two or three ply wood, shaped to stream-line form. The propeller shafts were carried in ball bearings. The gasoline tanks had a capacity of 2,000 gallons, and the date, July 14th, 1916, marked on one of them, is thought to indicate the date of the launching or commissioning of the vessel.

CONTROL AND ARMAMENT.

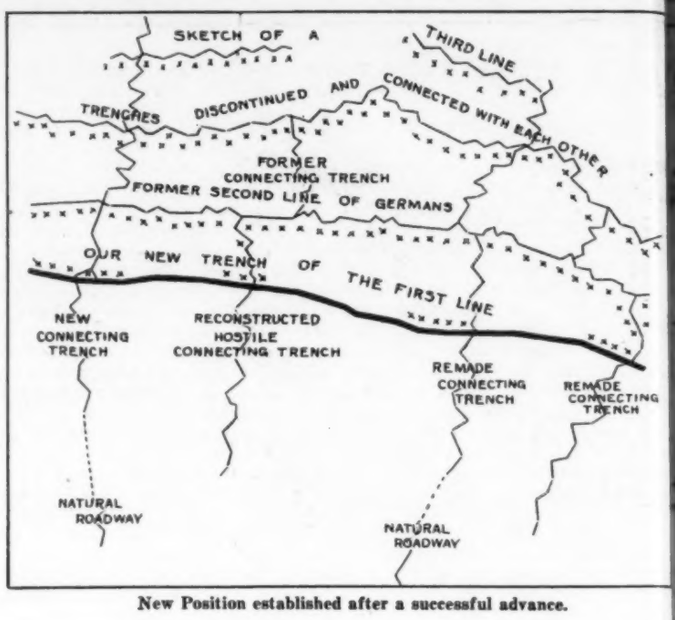
Forward of the engine room of the forward gondola, but separated from it by a small air space, was first the wireless operator's cabin and then the commander's room. The latter was the navigating platform, and in it were concentrated the controls of the elevators and rudder at the stern, the arrangements for equalizing the levels in the gasoline and water tanks, the engine room telegraphs, and the switchboard of the electrical gear for releasing the bombs. Provision was made for carrying sixty of the latter in a compartment amidships, and there was a sliding shutter, worked from the commander's cabin, which was withdrawn to allow them to fall freely. Nine machine guns were carried. Two of these, of 0.5-inch bore, were mounted on the top of the vessel, and six, of smaller caliber, were placed in the gondolas—two in the forward, one each in the amidships ones, and two in the aft one. The ninth was carried in the tail.—*Engineering Supplement of the London Times.*

The Alimentary Aspects of Whole-Meal Bread

AN article in *Il Morgagni* of October 27th by Dr. E. Bertarelli, professor of hygiene in the University of Parma, who has made a special study of the medical and economic aspects of food, is interesting to British medical men on the institution of food control in this country. Many physiologists remain skeptical as to the exact utility of the protein substances in a bread rich in bran. Nor is it sufficient to insist that by introducing bran into bread there is also introduced a higher percentage of organic nitrogen which is lost in white bread; it should also be shown that this nitrogen is really capable of being utilized. On this point there is discrepancy of opinion which blames the bran as exciting peristalsis, and causing slight but undeniable catarrhal inflammation of the mucous membrane of the small intestine, so that in consequence the utilization of the nitrogen is in effect less than with the consumption of ordinary white bread. This accusation is especially leveled against a whole-meal bread prepared by softening the grains of wheat for a short time only and immediately afterwards grinding them in a machine which lacerates them and, by the addition of water, converts them into a homogeneous dough. Such a dough is not easily leavened, is but slightly changed, and is full of water and coarse detritus of hard bran. Nowadays whole-meal bread, or what is commercially sold under this name, is prepared in the same way as white or brown bread, using flour containing about 90 per cent of entire wheat. Complete utilization of the grain is not a preconception of bigoted economists who desire at all costs to save fragments of alimentary substances from waste. It ought to be possible, without causing any harm to the organism, and by making use of the outer portion of the spermoderm of the grains, to use the protein substances existing in the bran. It ought not to be impossible to find some method by which the bran will have no harmful effect, even if it is used in the same relative quantity as it is present in the grains. Economists have no difficulty in showing that the utilization of the whole grain affects a gain of even 15 per cent in comparison with present methods, but in reality the question is how to make the bread in such a way that the physiological gain runs parallel to the economic. This is the point to which Prof. Bertarelli draws attention in discussing the preparation of "natural" bread, in which the entire grains, or caryopsides, are soaked in water for a long time so that they undergo changes comparable to those which take place when barley is malted, affecting every part of them from the outer layers to the starch itself. By this means, he suggests, there takes place a partial hydrolysis of the cellulose and a separation, by maceration, of the different layers so that it is improbable that there would be left in the bread fragments of resistant and hard bran similar to what is found in a bread prepared from whole grains ground in the usual way. After baking, a good bread is produced which is rich in bran, but which, neither in appearance nor taste, or in the presence of detritus of scaly fragments of bran, resembles some of the usual types of bread which are classified under the terms of whole-meal bread. Moreover, leavening is absolutely perfect.—*The Lancet.*



Plan of typical German defense lines.


SKETCH OF A THIRD LINE
TRENCHES DISCONTINUED AND CONNECTED WITH EACH OTHER
FORMER CONNECTING TRENCH
FORMER SECOND LINE OF GERMANS
OUR NEW TRENCH OF THE FIRST LINE
NEW CONNECTING TRENCH
RECONSTRUCTED HOSTILE CONNECTING TRENCH
REMADE CONNECTING TRENCH
REMADE CONNECTING TRENCH
NATURAL ROADWAY
NATURAL ROADWAY

New Position established after a successful advance.

Preparing an Offensive*

Principles and Methods of Trench Fighting

Is a breach in the lines possible? That is the great question of the day since the brilliant *début* of the Franco-British offensive on the two borders of the Somme. And this question, of such capital importance to us, must be answered with entire confidence. Only everybody should know that a complete success can be bought only at the price of a formidable effort, for the difficulties to be surmounted are gigantic.

Hence we will essay to sketch rapidly the form which the war has taken, with the system of trenches, and the principal means employed before, during and after the battle, in order to gain it with as little sacrifice of our men as possible. The manner in which the offensive has been conducted since the first days of July proves that considerable results can be obtained without important losses of infantry. Did not one of our army corps carry by assault the second German line for a distance of many kilometers with the loss of only a few hundred men?

The problem which the command must solve is simple, like all the art of war. But if the premises are almost infantine, the conclusion, i. e., in the kind of solution applied, is always very complex.

Two lines of trenches being given, *A B* and *C D*, the French and the German, separated by a space varying from ten to one hundred meters on the average, a space battered by cross-fire from infantry, machine-guns and artillery, bristling with one or two networks of barbed wire, how can the troops occupying *A B* take *C D* and continue to advance beyond that line? This has been our problem to study ever since the battle of the Marne, when both French and Germans found themselves come to an end of their physical and moral strength, after a pursuit by forced marches of more than one hundred kilometers.

All our attacks, all our offensives of 1915 have had one result: to instruct us in the things we needed to know. It was necessary to deduce a new doctrine from the given facts. It was necessary to profit by so dear-bought an experience, so that a general forward march should not risk degenerating into an inconsiderate squandering of precious lives.

The method employed by our English Allies and ourselves at Artois since July 1 is the best application of this experimental doctrine.

A LONG PREPARATION IS NECESSARY.

To attack and attain success with as little loss as possible it is needful: (1) To suppress the barbed wire. (2) To prevent the fire of the enemy's infantry and machine guns. (3) To neutralize the action of the hostile artillery. (4) To prevent action by the reserves. This essential part of the task devolves almost entirely upon the artillery.

The *rôle* of the infantry is as follows: (1) To prepare the trenches so that they can be sortied from. (2) To cut new communication trenches. (3) To create "places of arms" in order to facilitate the gathering in these places of such reserves as are ready to support the first line. (4) To create magazines for stores and munitions. (5) To enlarge the trenches giving direct access to the trench of departure.

While the artillery's preparations require only a few days, that of the infantry demands almost a month of labor, since it is only at night that any work can be done. By day, in fact, the tiniest pellet of earth thrown over the parapets, the slightest suspicious noise in the trenches, has for its immediate consequence a bombardment which is too often effective.

A glance at our sketches will show the principal arrangements to be made. First there is the preparation of the parapet, which must be made easy to cross. For this purpose the means recognized as best is the cutting of a stairway, as indicated in one of our sketches, on which, while waiting for the attack, the sharp-shooters can act lying down. An attempt was made to apply ladders to the vertical parapet, but the result was not brilliant, and the difficulty to be surmounted in climbing them engendered fatal confusion from the beginning.

Afterward the *places d'armes* must be dug so that they may be occupied by sections of the second line in close proximity to sections of the first line without interfering with the latter in the trench of departure, while the sections of the third line wait in the trench of the second line. Thus, when the hour of attack arrives, the first wave is launched. While this is being done the *places d'armes* empty themselves automatically by the enlarged communicating trench into the first line trench, and the units of the third line come in their turn to occupy the *places d'armes*, and so on, till the troops destined for the assault are exhausted.

THE TASK OF THE ARTILLERY.

When all these painful labors are finished—painful physically, especially in rainy weather, and also morally—it is time for the artillery to act.

To suppress the entanglements of barbed wire a bombardment by the 75's is sufficient. Before arriving at this conviction, various methods were tried: throwing petards of melinite, cutting by hand, chariots loaded with explosives and brought into the entanglements by means of windlasses and ropes operated from the interior of our trenches, etc. All these divers systems led to disappointments, of which the most important was the possibility afforded the enemy of replacing the wire destroyed. The action of the 75's produces breaches sufficing to allow passageway. The only inconvenience is the necessity of using an enormous quantity of projectiles. To prevent the fire of hostile infantry the most efficacious bombardment is that of the heavy artillery, combined with the action of the aerial torpedoes. Such a fire disorganizes the trenches. We see planks, bags of earth, parapets, timbers, flying in the air. The soil is torn up as if it had been plowed in every direction. Finally the deep shelters, which are often "blinded" to boot, wherein the enemy takes shelter during the bombardment, are shattered in their turn, their occupants terrified by the formidable shock, the fantastic effects of the gusts of wind, the trying noise of the crashes, detonations, falling in of ramparts.

To annihilate the fire of the hostile machine guns it is necessary to have a careful reconnoitering beforehand as to their emplacements: salients and re-entrants of the line, changes of its direction between the first and second lines, in the second line when this laps over the first, etc. This study must be minutely made with the assistance of artillery officer observers.

As for hostile artillery, the infantry justly demands not to be made the target of its fire during action, for shells spread confusion everywhere. Hence the aeroplanes must report minutely on enplacements of hostile batteries before any attack. During the attack, while our artillery overwhelms the German guns with projectiles, our avions, planing above them, must indicate those which are not battered down and those which enter into improvised action.

Finally, the artillery must complete its work by preventing the entry into line of the reserves. While the preparation continues, they do not stir from their shelters in the second and third line. As soon as the fire has ceased, the garrison of flat caps precipitates itself upon its positions. The artillery must then range its fire on the second and third German lines and continue it while our infantry gains the first. Such a fire is called "barrier fire."

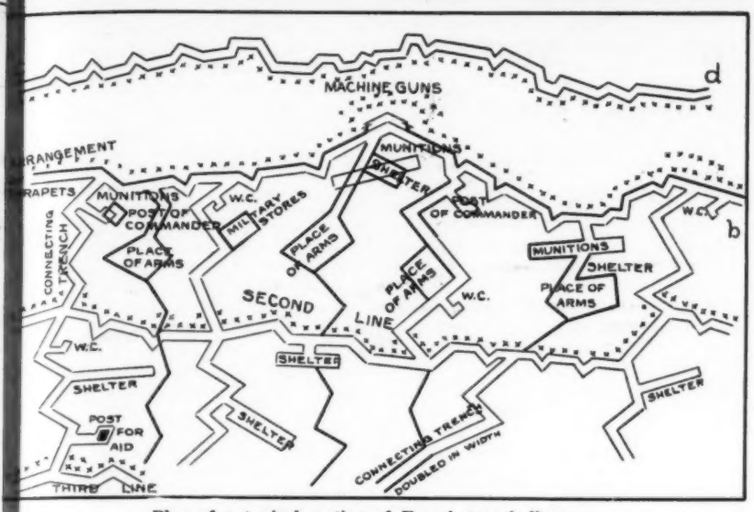
A new method was inaugurated at Artois. To obtain precise knowledge of the "work" accomplished by the artillery the system of patrols was organized. Volunteers, in little bunches of thirty to one hundred men, execute daring raids into the enemy's lines, clean out the bombarded trenches, examine the state of the defenses, and give exact information to the command of the situation of the positions to be carried. These raids have given the best of results.

Excellent preparation is the indispensable condition of success. Obviously, then, the chief command is not able to undertake an offensive at a given point on a day's notice. Before the attack there must be preparation for it. Moreover, aviators assure the mastery of the air. The enemy's flyers have all been compelled to stay within their lines. The hostile army is absolutely "blinded," by being deprived of its means of observation. All is ready. The infantry can go into action and take possession of the terrain to be conquered.

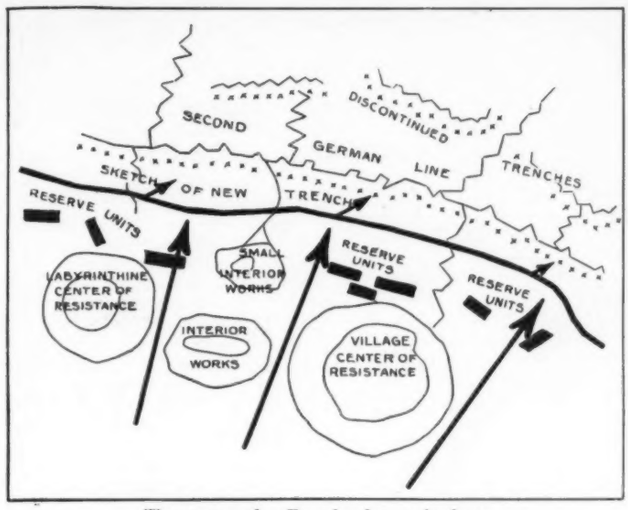
THE ATTACK IS LAUNCHED.

An absolute and impressive silence succeeds suddenly to from three to seven days of a deafening clamor! "Charge, with the bayonets!" and the first line leaves. The artillery ranges its fire. The barrier fire begins. For the attack to succeed, four things are re

*Lectures pour Tous (Paris).



Plan of a typical section of French trench lines.



The course of a French advance in force.

quired: (1) To break up the first line of the enemy. (2) To break the second line and others if they exist. (3) When finally arrived in the free terrain, after an unbroken assault of several kilometers, to prevent the enemy from forming a new barrier. (4) Finally, when the breach has been achieved, to spread out a covering line of fresh troops in mass.

The German organization is usually as follows: In the first place, along the entire front there is a first line of continuous trenches, made in the form of teeth of a saw, so as to limit losses by "compartmenting" them, and in order to permit flanking with machine guns. From 150 to 300 meters, at most, behind this, is a second, and often a third line, connected with the first and with each other by intersecting trenches. Finally, intermingled with these lines are centers of resistance, comprising either enormous works formed of intricate trenches (e. g., the famous Labyrinth, the White Works of Neuville), or woods, or villages, with artillery and machine guns under cupolas, like the villages of Montauban and Biaches. These centers and trenches are all defended, naturally, by strong barbed wire, forming the first resistance.

Finally, from 500 to 2,000 meters or more in the rear, a second line of defense, which is not entirely continuous, but whose cross fires, flanking each other reciprocally, constitute veritable traps.

WAVES OF ASSAULT.

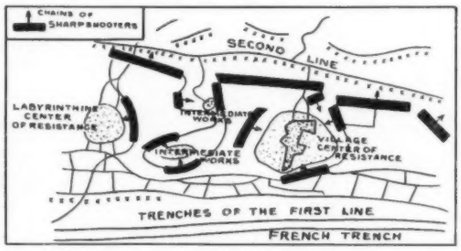
The battle begins. The first German trench is to be broken. If the space to be traversed is small, it is advisable to make a sortie all together (the given hour that of the cessation of the fire of preparation) and to rush into the opposite trench before the "Boches" have issued from their shelters. But, if the nature of the terrain makes the distance too great, over 100 meters, for example, it is necessary to proceed by a series of rushes, opening fire at each rush. While the first "wave" sorties from the departure trench, the *places d'armes* are emptied, their units coming to replace the ones just departed. The second wave sorties in its turn, and then the third. The troops of the first line then comprise two or three waves at the minimum. As soon as the entanglements of the partially destroyed barbed wire are reached the period of individual combat begins. Each man fires at will, crawls or rushes, and surmounts obstacles. They reform on the other side and the whole wave pours into the submerged hostile trench.

When this is conquered, it is "cleaned out" to the very bottom. No enemy capable of injuring our men, or shooting them in the back, as has frequently happened, must be allowed to remain. This task accomplished, the men reform and go on to the assault of the next trench. "Forward!" always. There is no stopping, theoretically, for the first line. It must go as far as possible, till completely used up. Besides, thus to take the first trenches, expressly neglecting the hostile centers of resistance, is relatively easy; and the better, and the more minutely regulated the artillery preparation, the easier it is.

Whenever the first lines have been taken, i. e., conquered and emptied of the enemy, the element of the unknown enters. Apprehension of a trap unnerves everybody, the rate of march slows up, and the least intervention of the enemy has a paralyzing effect. The first line diminished, and lessened, also in *morale*, stops, therefore, of its own accord. It is now up to the units of the second line, popularly known as reinforcements, to intervene to continue the movement and go on to the enemy's second line.

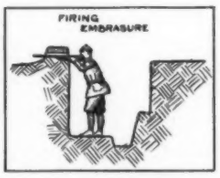
THE ACTION OF THE REINFORCEMENTS.

The easiest part has been done. For we must not forget that our artillery has disorganized the first opposing lines. Only the centers of resistance still hold, though it may have been possible to demolish their borders and thus partly neutralize their force. Then their communications have been cut, and thus isolated and surrounded; there is nothing to be done but lay siege to them, for to take them by brute force is horribly costly—which is borne witness to by Labyrinthe, Carency, Neuville, Saint-Waast, Abatis Wood, and the Tron-Bricot in Champagne.

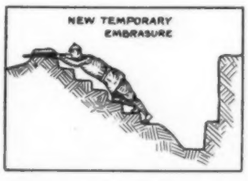


Centers of resistance invested after adjacent trenches have been captured.

There remains the most important problem to be solved in "making the breach." This is the question of reinforcements, the action of the second line. It must be remembered that these men have undergone severe trials. They have waited for long hours in our second-line trenches, then in the *places d'armes*, finally in the departure trench. They have assisted at our formidable preparation by artillery, have experienced the combat of the first line, which they have seen, or at least heard, have been more or less subject to the shells of the enemy, a highly demoralizing circumstance. Finally, when launched in their turn, they have marched among our dead, have beheld our wounded; and they have not the rough immediate action to enable them to react more easily. Hence, it is highly important that these troops of the second line should have an unshakable *morale*. It is also important to engage them in action at an opportune moment, i. e., in general, as soon as the first waves have submerged the first hostile trenches.



Ordinary trench.



Trench with stepped parapet.

The task, therefore, of the reinforcement units, following the invading flood at a distance of four to five hundred meters, is first of all to take possession of the borders of the enemy centers of resistance to finish annihilating them. A few companies are sufficient for this. The rest continue to press forward straight ahead. By the time they have joined the elements of the first line, who have come to a halt, as we have seen, there is no need of elaborate tactics; the only chance of success lies in immediate rough assault.

If our reinforcements succeed at once in crushing the second opposing line, then the breach is made, the open field is before us, the large units of the reserves can leave in their turn to overspread the country and exploit the success.

If not, then the work must be renewed before the second lines of the enemy, but now under better conditions than at the start. But haste is necessary, for every day lost is fresh strength to the last remnants of enemy.

BEFORE THE SECOND LINE.

Suppose now that the action of the reinforcements has not been effective, and that the second opposing line remains almost intact. The first thing that the whole recompleted line starts to do instinctively, after having seen its efforts at assault repulsed, is to seek shelter from the blows which it receives and which it cannot return with equal efficacy.

All the implements are in operation, and everybody is either digging or shooting. During this time, on the terrain gained, the prisoners are being sorted out, the last bits of resistance are subdued, munitions are brought up in haste, and in all the "cover" afforded by the terrain units are sheltered, whose duty is to relieve the men at work from time to time, and to be ready to withstand a return offensive of the enemy.

Then, too, since going and coming on the immense field of battle cannot be done without risks, what remains of the former trenches of the enemy are utilized, as well as all the natural roadways, to piece out the new trenches of communication. Finally, when night falls, our artillery must move forward to get in touch with the infantry once more. All this new organization of men, who are worn out, and to whom it has been impossible to give prompt material relief, takes not only time, but superhuman effort. But time is a pressing matter, for the enemy is not resting inactive. Filled with fear by the violence of the combat, demoralized by defeat, the enemy has assembled all the troops available in the vicinage. When these arrive they naturally go to work to dig new trenches. At first they profit by a period of quiet to repair the former second-line trench, now become the new first-line trench. The trenches discontinued or outlined farther back are afterward completed and connected with each other. Still farther back a new position of cover is organized with feverish haste. It is clear that "the time factor" becomes preponderant, if we desire to renew the attack before the enemy has reorganized his new position.

The preceding details of operation show that since the end of the Battle of the Marne we have been forced to adopt novel tactics. We have learned that the accumulation of cross fires from infantry and artillery, joined to a hitherto unheard of prodigality of accessory defenses (barbed wire, "wolf-holes," *chevaux de frise*, etc.), normally prevents any appearance in the open. Hence the preponderant part played by preparation for the attack, a preparation which must be elaborated to the smallest detail.

When, after a period of cessation skillfully reduced in length, the offensive is recommenced, at last we find ourselves, after this gigantic assault of many kilometers, in the open zone! War then takes on its ordinary physiognomy. The rapidity of concentrations and movements, the mass action of our cavalry, the skill of maneuvers, the endurance of the soldier on march, such are the eternal factors of success.

The Temporary Stars*

Their Characteristics and Theories Regarding Them

By Maurice Fouché, Assistant Professor at l'Ecole Polytechnique, and Secretary of the Society

THE Latin naturalist Pliny relates that about 130 B.C. the astronomer Hipparchus, who made his headquarters at Rhodes, was struck by the sudden appearance in the sky of a star of unaccustomed brightness, and that this extraordinary event led him to undertake the compilation of a star catalogue, to the end that if a similar phenomenon should ever occur again it might be determined whether the star in question were really a new one. Delambre dismissed this incident as a fable, perhaps a bit hastily; for in the Chinese encyclopedia of Ma Tuan Lin, translated by Bigot and extending back to the year 613 B. C., there is mentioned under date 134 B.C. a star which appeared suddenly in the constellation Scorpio, between the members β and ϕ. As Ptolemy also reports for the year 128 B. C. the completion of Hipparchus's catalogue, the dates seem to accord sufficiently well to overcome any objection to the tale of Pliny.

Here we have a very handsome new star of at least the first magnitude. We know nothing about the length of time during which it remained visible; only with modern times do we find precise and complete observations upon these curious temporary or new stars, or novae, of which up to the present there have been seen twenty-nine. Seventeen of these attained or surpassed the first magnitude. We extract from the list given in *Flammarion's Annual* the following particulars regarding the oldest and the most interesting, after that of Hipparchus.

123 (A. D.); a nova of first magnitude between α Herculis and α Ophiuchi. Nothing further is known of it.

173, December 17; a nova of first magnitude between α and β Centauri; disappearing after eighteen months, according to the Chinese text, after showing the five primary colors, in order.

369; a nova visible during March and April, position and magnitude unknown.

386, April 5; A nova between λ and ϕ Sagitarii, lasting from April until July.

389; a nova near α Aquilae, comparable in brightness with Venus. Disappeared after three weeks.

1012; an extremely brilliant nova in Aries. Visible for three months, during which it underwent pronounced variations, at times fading from sight altogether.

This brings us to the magnificent star of Tycho Brahe, which appeared suddenly on November 11th, 1572, in the throne of Cassiopeia. This star was a veritable giant. Sirius, Vega, even Jupiter, paled before it; and it was visible in broad daylight. The astonishment and terror produced by this apparition may easily be imagined. It was believed to be a sign of celestial fire, the more readily since the whole of Europe was at the time in a religious and political turmoil from the massacre of St. Bartholemew, in August preceding, and the events connected with it. However, the new star soon faded and went out, after lasting in all barely seventeen months.

Thirty years later, on October 10, 1604, a nova appeared in the Serpent. This was observed and followed by Kepler—without a telescope, of course, since the first of these instruments was constructed by Galileo in 1609. It surpassed the first magnitude and exceeded the brightness of Jupiter; but it was not as bright as Venus or the nova of 1572, being invisible in daylight. It fell to the second magnitude in February, 1605, and disappeared from view in January, 1606, after an existence of fifteen months. And if we now mention a very bright star recorded by the Chinese as visible in the southwest in 1609, we shall have completed the tale of the novae of great magnitude.

Since the middle of the nineteenth century, however, the greater attention paid the subject and the progressive improvement in instruments of observation have made possible the chronicling of eight more modest novae, ranging from first to fifth magnitude. In 1866 opportunity was first afforded to turn the spectroscope upon one of these enigmatic bodies. On May 12th in this year a star of second magnitude appeared in the Northern Crown; two days later it had faded to third magnitude, and by the end of the month it was no longer visible to the naked eye. After several oscillations it fell to magnitude 9.5 and held definitely to that figure. Upon subsequent examination of the catalogues it was found always to have been in this position and of this brightness. Its spectrum was that of hydrogen, with several additional dark lines, presenting a marked similarity to the spectrum of the solar protuberances, which had before that date been observed during total eclipses. Unfortunately the spectroscope was not yet capable of following the modifications of the spectrum during period of decline.

Notable progress was realized in the observations of a nova appearing March 14th, 1876, in Cygnus. At first of third magnitude, by December it had faded to seventh; a little later it fell to twelfth, assuming the appearance of a nebula, with a sensible diameter. The deduction that in the course of their evolution these strange stars may be transformed into nebulae, as unexpected as it was important, has been completely borne out in the behavior of subsequent novae; and this not merely by the appearance of the star to the eye, but by the changes revealed in the spectrum, which, with the latest apparatus, can be followed for a much longer time than was formerly possible.

The so-called planetary nebulae present distinctive spectra of bright lines, some belonging to hydrogen and helium, others, in the failure of efforts to identify them with any known substances, being attributed to an hypothetical element to which has been given the name nebulium. Now all the novae observed since that of 1876 have shown us an identical series of spectrum changes. In the beginning are noted the very bright lines belonging to hydrogen, helium and calcium —often standing out distinctly against a continuous background of feeble luminosity. This is the spectrum which we have noted as resembling that of the solar protuberances. Little by little the bright lines become less numerous, the continuous background, where this existed fades entirely out, and there are left only a few bright lines, altogether like those produced by the planetary nebulae. Such are the observations which have been made—in particular upon two stars of 4.5 magnitude appearing respectively in 1892 and 1898, in Auriga and Sagittarius.

The star Novae Persei, first seen on February 21, 1901, and which attained first magnitude, presents extraordinary interest. It lasted only a short time; within a month of its debut it was barely visible to the naked eye. Photographs taken at the Juvisy Observatory showed it surrounded by a nebulous haze. It was later recognized that this was not real; the objective, achromatic for the light of ordinary stars, was quite unsuited for the very refractive light of this nova. But attention had been called to the singular appearance, and in the course of the efforts to study the illusory nebulosity a real one was unexpectedly discovered. This had roughly the form of a ring surrounding the star, and expanding constantly with prodigious velocity. As no success crowned the efforts to determine the parallax of the new star, it seems probable that the star is at a very considerable distance, with parallax below the lower limit of measurement.

From these suppositions it would follow that the ring in its expanson approached, if indeed it did not actually attain, the velocity of light. Certain astronomers have hesitated to admit such a possibility; and I believe that to-day, with some of the latest theories of physics demanding that material velocities be incapable of equaling that of light, this hesitation should properly be even greater. Wilson and Kapteyn at the time essayed to explain the phenomenon by supposing that the nebular structure had always existed about the star up to a tremendous distance. Then, after the flaring up of the central body, we could at a given moment see that part illuminated by the abnormal light radiation. If the new brightness had persisted, we should have been able to see, first the parts of the nebula closest to the center, then, as the light advanced, additional regions further away, until the whole mass were finally visible. But the extreme brilliance of the central star had lasted only a few days; the regions first illuminated soon ceased to be so, and lapsed into invisibility as the outburst of brilliant light passed beyond them. So all we could see at any moment was the relatively narrow zone then being traversed by the maximum radiation; and this zone, remaining fixed in width, receded from the center with the passage of time. The velocity of light being known, the true distance travelled by the zone of illumination was easily calculated; and comparison of this with the apparent expansion gave the distance of the star from the earth. The figure thus obtained, 300 light ye corresponds to a parallax of 0.01 second, which, enough, is just below the limit of measurement. I necessary to state that this explanation has been by grave objections, and has not attained general ceptance; but it possesses inherent interest and gance sufficient to justify its repetition, even if it demonstrably false.

The two most recent novae appeared in Gemini, of fifth magnitude on March 16th, 1903, one of fou magnitude on March 13th, 1912. The latter particula was widely observed. Its parallax was measured 0.011 second, which would place it at a distance of light years. By October 17th, 1913, it had faded magnitude 9.5 and presented an apparent diameter about two minutes, which, at the distance nam would give it a radius of more than a hundred tim the earth's distance from the sun, or more than thr times the entire radius of the solar system, from t sun to Neptune's orbit. Several observers were co vinced that they had seen in its spectrum the chara teristic lines of radium and its emanation; but this uncertain.

We see, then, that all temporary stars posse certain common features. Now, we cannot admit th a bright star is suddenly formed out of whole clo in a place where none was before. It is true that the case of Nova Persei, in spite of the most pain taking study of photographic plates of the region which it appeared, nothing was found. But this prov merely that before its outburst the star was too fai to be photographed. In every case we have to do wi a very feeble star, which suddenly acquires an extra ordinary brightness, and then fades rapidly, while th matter of which it was formed disseminates itself in short time throughout the immense space occupied b the nebula into which we see it pass. All this is a complished in a few months, which is but an instan on the calendar of stellar evolution. We find her all the characteristics of what we are wont to call a explosion. But what can be the cause of an explosio on such a prodigious scale?

I realize that I am here verging toward dangerou ground. Physics as we know it can seldom be applie without a great deal of reserve to the celestial bodie in which every condition is so different from thos which the physicist can realize in his laboratory. A one time we see, in the nebulae and the tails of comets matter in the last stages of attenuation; at anothe we encounter, in the interior of sun and stars, pres sures of the most formidable character, of which w can know absolutely nothing save that they surpass th wildest conceptions of which our imaginations ar capable.

What happens to the known laws of physics unde such conditions? Shall we agree that it were wise to abstain from all hypothesis, to lay these question over to a time when natural science in general shal be more advanced? Emphatically, I say no. In th present and future, as in the past, truth is to be de veloped only by a tedious process of trial and error And every step in this process constitutes a distinc scientific advance.

It is fitting, therefore, that every discovery in physical science be immediately pressed into service by the theorists among the astronomers. Indeed, it seems that every important discovery presents perforce new problems of fundamental importance, and reopens questions of abstract theory that had been supposed definitely closed. It was thus that the discovery of radium transformed physical chemistry. The reader is familiar with the singular properties of this extraordinary substance, luminous in the dark, maintaining its temperature about three degrees below that of the surrounding medium, transforming itself, by an evolution of exceeding slowness that has so far defied every effort at acceleration or retardation, into a series of emanations, which all lead to a common goal in the formation of helium.

At first it was wondered whether this strange behavior did not cast doubt upon the universally accepted principle of conservation of energy. This difficulty is avoided by assuming that radium contains within itself prodigious reserves of energy, which it frees little by little. But the final translation of radium into helium does definitely break down the old concept of the indivisible atom. The atom has become, in the modern

*Address delivered before la Société Astronomique de France. Translated, with abridgements, for the SCIENTIFIC AMERICAN SUPPLEMENT from *L'Astronomie*.

viewpoint, a miniature solar system in which thousands of negatively charged ions gravitate about a positively charged electron. It must therefore contain within itself a quantity of energy vastly beyond what can be produced by ordinary chemical reaction. The possibility at once suggests itself that radium is not an exception, that perhaps all atoms undergo the same slow transformation which, little by little, converts them, with liberation of energy, into lighter atoms. The generalization is an easy one; it is sufficient to suppose that the evolution of ordinary substances is tremendously slower than that of radium. Then, taking one more conjectural step, we have to picture the prodigious explosions that would be produced if means were found of bringing about sudden atomic dissociation, of forcing the atom to give up in a fraction of a second the energy which it ordinarily distributes over the centuries or millennia of its evolution. Beside such a development of force our most violent chemical explosions would be but the scratching of a match.

Let me now return to the temporary stars, from which I seem to have wandered far. The explanations that have been advanced for them can be thrown into classes, according as they rely upon collision or explosion. Two stars coming together in their paths would lose with great suddenness the greater part of their velocities; and the force thus diverted could only transform itself into heat, which would raise considerably the temperatures of the colliding bodies. The penetration of a star into a nebula has similarly been called upon to furnish an explanation of the novae. But while accurate numerical data are out of the question, we may well question the sufficiency of the quantity of energy liberated by the most violent stellar collision to produce the very large and rapid increase in luminosity seen in the novae. Spectrum analysis has likewise developed objections to the collision theory; but in fairness it must be said that it still has its supporters.

Those who believe that the novae are due to explosion assume that the star is surrounded by a tolerably cool, solid outer crust, and that in some way this is ruptured, allowing the much hotter interior portions to rush out. Among the causes mentioned as capable of producing such rupture are the close conjunction of two stars. This recalls the collision hypothesis; but it is not necessary here that we have an actual collision. It would be sufficient for the disturbing body to approach the other close enough to produce, in the fluid interior mass of the latter, fluxes capable of breaking through the comparatively feeble resistance of the envelope. But here again we fail to recognize with any certainty a source from which a temporary star could draw the prodigious quantity of energy which we see it dissipate into space.

Indeed, such explanations as appeal only to ordinary mechanics and thermodynamics appear to be inherently insufficient. One feels that there must be something more involved. Innes, astronomer at the Cape of Good Hope Observatory, has had the courage to propose an entirely new theory, of which I shall indicate the salient features. More than this I cannot do, since present circumstances have made impossible the international discussion by competent authorities, which this hypothesis would ordinarily have enjoyed.

Innes admits the principle of universal atomic evolution on which I have digressed at some length. And on this basis he builds up a theory which seems to have a very general application to stellar evolution. All heavy and complicated atoms, he says, break down slowly, like radium, to change finally into lighter atoms. But, under appropriate conditions, by the side of this infinitesimally slow evolution there exists the possibility of explosion, of sudden disruption of the atomic structure. And these conditions, he asserts, have to do with pressure. The heavier atoms can support but limited pressures; and if the limit is passed, explosion ensues, destroying the atom.

So much for the abstract theory. The application to the temporary stars is immediate. As a star cools, it contracts. The pressure inside the star increases; and the greater the total mass, the greater this pressure increase. There comes a time when the internal pressure exceeds the limit, and atomic explosion follows. It is sufficient that this should happen at a single point to be propagated throughout the mass of the star by the incredible additional pressures developing from the initial and local explosion. And then we have a nova.

According to Innes's theory, all stars of considerable magnitude must sooner or later blow up. I do not argue for or against the validity of his assumptions or the consequences which he draws from them; I am content with having called your attention to this conception, assuredly new and original. We may raise doubts and submit objections; but whatever the fate which the future holds for this hypothesis, it will at least have the merit of bringing new ideas into the discussion of problems relating to the genesis of the stars and their ultimate destiny, and in this way of preparing the ground for more profound investigations and more complete and satisfying explanations.

Development of Our Potash Industry*

By F. M. deBeers

AMERICAN chemists have been looking for potash in this country for a great many years and several deposits and sources were discovered years ago and then neglected by capital, because of the moderate price of the German article. Most, if not all, of the present sources were known before the war, but the industry did not seem then to promise returns large enough to warrant the hazard of the new undertaking. Consequently nothing was done until our supply was suddenly cut off and a brief review here of what we bought on the average per year from Germany may not be out of place.

In round figures the following list shows approximately what we imported each year:

	Tons.
Potassium muriate (80 per cent)	250,000
Potassium sulphate (90 per cent)	50,000
Manure salts (20-38 per cent)	200,000
Kainit (12-15 per cent)	500,000
Total	1,000,000

Figuring all the potash as K_2O or potassium oxide would show about 360,000 tons of the oxide in the above importation. Our yearly supply of German potash cost us about $20,000,000 before the war. During the balance of this paper when I refer to percentage of potash I will mean per cent of potassium oxide or K_2O.

The question of whether we can produce this large amount of potash here and take care of our increasing demand is entirely too large for me to even consider, particularly as no one seems to know when the war will end and what Germany plans to do then. We know she can produce potash very cheaply and we also know we have large but scattered supplies of potash-bearing materials here, but the whole thing is in too primitive a state now to warrant any guesses.

Some of our present developments will survive any competition, but others are simply intended to fill a present demand. In this paper I am only attempting to explain where we can secure our raw potash salts and what has been done up to the present that has come to my notice. The refining and purification of these raw salts has been done here before the war, and our large chemical companies can without doubt take care of this phase of the situation. Some of these raw salts can, of course, be used in their raw state in certain industries. Most of my information is first hand and my estimates as to quantities are of course approximations. I wish here to say that some of my information was obtained from reports by experts in other industries and to all these men I acknowledge my indebtedness.

*Paper presented at the 11th Annual Convention of the American Meat Packers' Association, Cincinnati, October 9 to 11, 1916.

Our sources of supply can be divided into two classes, one containing those which are by-products and the other class consisting of industries where potash is the principal product. We will consider the by-product potash first.

Wood ashes have been the source of potash ever since our ancestors knew how to use same. After the German industry had developed the making of potash from ashes was practically abandoned, but lately I believe our supply is being augmented from this source. I have not been able, however, to locate any data that is sufficiently complete and reliable as to what we can expect in total tonnage, etc. I am of the opinion that this source is not of very great importance from a commercial standpoint.

Bittern produced in the manufacture of salt from sea water contains potash, but the quantity is very small and it is very difficult to separate from other salts. Bittern from the water of our Great Salt Lake is now being treated by three companies, and this runs about 2 per cent potash. Each company has its own method of separation and purification, and if they all operate up to their expected capacity they could turn out approximately 30,000 tons of raw salts per year, running about 20 per cent potash.

This figure is only approximate, as before stated, but it will serve to show that this source is not very important and high freight rates to Eastern points make it appear as if this process might have a hard time surviving after the war. The bittern also contains about 5 per cent magnesium oxide and, because of same, my conclusion may be unfair.

Wool is scoured or washed before it can be made into yarn, and this wash water contains about 3 per cent total solids after the wool grease and dirt have been separated out. These solids will average over 25 per cent in potash and are easily recovered. This material is available at the Atlantic Seaboard and, because of the value of the wool grease, it is very probable that the manufacture of potash in this way can be commercially successful. Another reason for saving this waste lies in the fact that by doing so this objectionable wash water is not run into streams or sewer systems. While the potash made should be easily marketable, the quantity obtainable from this source cannot be very great and I regret I have no figures as to tonnage. The potash is in the form of carbonate and potash soaps.

Fish water produced in menhaden factories contains about 8 per cent solids, and these solids will average 5 per cent K_2O and over 16 per cent ammonia. This cooking water should be saved and can be converted into a most profitable by-product. The industry is not a large one, however, and not more than 15,000 tons of dry fertilizer averaging as above could be produced per year based on the average kill of our Atlantic factories for the past five years.

In the making of alcohol from cane molasses there is a liquid residue left in the still which contains 5 per cent solids. These solids will average 9 to 10 per cent potash and also contain some ammonia. The potash is probably in the form of carbonate and sulphate. A few distilleries are now saving this slop and recovering the potash. If all the slop made in this way were saved and the solids recovered, we could count upon a production of about 200,000 tons of 10 per cent potash per year as a maximum, and I am inclined to believe that this estimate of mine is a little too high.

Many of our beet sugar factories employ the Steffens process for recovering the sugar from their molasses, and after the sugar is made in this way there remains a waste solution averaging about 4 per cent solids. Approximately half our factories have this waste material. These solids can be recovered and many European factories are doing so, but up to the present time our sugar makers, with a few exceptions, have done nothing. A dry product made from Steffens water will average over 6 per cent in ammonia and over 12 per cent in potash in the form of carbonate. Our American farmers will probably produce seven million tons of beets this year, and if the Steffens process were used in every factory and all the water were saved, we could count on about 200,000 tons of products per year of the above analysis. We are expecting a decided and permanent increase in our production from this source within the next year.

In the manufacture of cement, the dust leaving the furnace carries a considerable quantity of potash salts, and these are being recovered by several methods. The most successful seems to be the Cottrell system and very large returns are obtained according to several authorities. I have estimated roughly that we could produce about 80,000 tons of potash annually in this way if the figures given me are correct. It is sufficient to say that several plants are now using this process successfully and one plant is now being built near Buffalo that will turn out potash as the main product and cement as a by-product. This, of course is a development of the feldspar situation to be discussed later.

Furnace gases from blast furnaces contain potash due to the volatilizing of the potash salts by the high temperature. This probably produces potassium cyanide and the amount of potash that passes away is enormous. My own figures seem so large that I am afraid of them, mainly because I have not had any direct experience or contact with this problem. If the statements of authorities, who have written in high-class journals are correct, this is one of our largest sources of potash and is, no doubt, being investigated thoroughly (and quietly) by the large producers of pig iron. The dust which settles in the stoves and boilers is now collected and sold to refiners of potash salts, although I could not find any data as to quantity.

The making of potash from kelp is being carried

out with partial success on the Pacific Coast. The present high value of this material and the absolute necessity of securing a supply has made it logical for some large users to put up plants for this purpose, and they are good investments no doubt for these reasons. I cannot see how this can be a permanent industry with potash at the price it was before the war unless someone perfects a process that will permit of a lower cost of production. This, of course, is only my private opinion, and I hope I am wrong, which is easily possible, as I have not had the opportunity to study the matter as closely as I would like to. If the kelp is thoroughly dried or burned, I am told it is possible to secure a product running over 15 per cent potash. So far as I know, no figures are obtainable as to production.

This about takes care of the development of our by-products as a source of potash. The remaining sources can be grouped under four headings: kelp, alunite, Western lake waters, and feldspar. There are some other minerals which contain potash, but personally I have not learned of any which are in sufficient quantity to be considered.

Potash from alunite is being successfully made in Utah, and I believe this industry is a permanent one. One of our large packers is responsible for the first commercial plant, and I am told that outside of the setbacks which must be expected in such a new development, the process is a success. According to my own figures, which are simply estimates, I would say that the production next year should be at least 20,000 tons of potassium sulphate 90 per cent pure—a very high-grade product. Other plants are now being contemplated, and we may soon have a much larger output. The ore itself runs from 8 to 12 per cent in potash and the process of manufacture is relatively simple.

The largest source available for quick use is out in western Nebraska and Wyoming. This field, to my way of thinking, is also a permanent one, and after the business has been standardized and the necessary experience secured, I believe our Nebraska friends can compete, if necessary, with Germany within a reasonable shipping radius. There are a large number of these small lakes running from a few acres up to several hundred acres apiece. Those containing potash salts have vegetation around their banks, while the alkali or soda lakes are barren. You will very often find two lakes side by side with potash in one and not in the other. Experts are now at work trying to locate the source of the potash that drained into these ponds and, if they are successful, we will probably be relieved of any worry as regards our supply. These lakes or ponds will average 10-16 per cent total solids and these solids when dried will contain 15 to 30 per cent potash, depending upon which lake is being worked. A fair average would be 12½ per cent solids containing 20 per cent potash. One small lake alone which is being worked now is said to contain over 300,000 tons of these salts. A large number of lakes have been bought and will be developed as soon as the new plants can be finished. This field should be permanent at least for a good many years before the lakes are drained. I should say that by the first of next January we will be getting 20 per cent potash salts from this district at the rate of 100,000 tons per year as a minimum.

Oregon has several lakes that contain very large quantities of potash as sulphates and carbonates. Some work is being done, but so far as I know there have not been any developments on a commercial scale up to the present time. I learned of one lake recently that I am told contains 18 per cent total solids of which 8 per cent is potassium carbonate, which certainly sounds very interesting.

Searles Lake in California contains a large quantity of potash, and a great deal of money has been and is being spent to produce a marketable product. The problem is not an easy one, as the brine contains a mixture of potassium and sodium sulphate, carbonates, chlorides and borates. They are very hard to separate, although I know that several hundred thousand dollars have been spent on a plant within the last year by the American Trona Corporation, which anticipates a large tonnage of potash salts soon. The brine used contains over 30 per cent total solids with about 5 per cent of potassium chloride. The company is figuring on an output of 40,000 tons per year of 80 per cent muriate, and so far as supply is concerned, they could operate at many times that rate for years to come, as the lake is very large.

Feldspar occurs in so many localities that we are all hoping that some American chemists will soon solve the problem of how to make potash from same on a commercial scale. The supply is practically unlimited. It averages from 8 to 15 per cent potash in the form of silicate and aluminate. One syndicate of miners in Colorado is producing 2,000 tons of finely ground and washed feldspar each day, which is all ready for a satisfactory process. Hundreds are experimenting, and if I had time I would be glad to explain some of the methods being tried. As soon as an economical method is discovered, we need have no fear about our supply, but such a method must be able to produce at a cost comparable with Germany's cost, which up to the present time has not been done to the best of my knowledge.

I have not attempted to explain any particular process used in making potash from any of these raw materials, as such information to be complete would result in a book, rather than a paper. After studying this question as carefully as possible, I am of the opinion that we will produce raw potash salts next year in sufficient quantity to supply about one-third of our average demand before the war, or equivalent to 120,000 tons figured as potassium oxide (K_2O). There is a chance that we may exceed this by 50 per cent if certain properties are worked or if new processes are developed, but even then we would have but half our requirements during normal times, and right now we could really use more than that. Our future as a larger producer depends entirely, to my way of thinking, on our success with feldspar, alunite, blast furnace gases, Searles Lake and other lakes in Nebraska, Wyoming and Oregon. We cannot secure much more than about 15 per cent of our requirements from the by-products first discussed, although many of these should be permanently profitable.

New Points About the Bagdad Railway

Referring again to the question of the Bagdad Railway, it is stated that during the period since the war the work on this line is being actively carried on, and the enterprise will no doubt be finished in the near future. At a recent date the principal tunnel of the line, the Bilemelik tunnel, was run through and it will be soon completed, the total length being somewhat over one mile. Work is being especially pushed forward on the Taurus section, and also on the section lying in the Amanus Mountains, it being considered of great importance to finish these sections because this will afford a direct connection between the Bosphorus and the Egyptian frontier. But the work is not confined to those parts of the line which appear to have a strategic importance, for it is being carried out upon sections of a less military prominence, and there were lately opened several portions situated in the north region of Mesopotamia, and an extension of the line is looked for from the coast to the Euphrates; another portion is situated farther south in the neighborhood of Bagdad. The unfinished parts of the line in the different regions of Asia Minor divide the entire railroad from Konia to the Euphrates into three sections, and a fourth can be added which starts from Bagdad and runs northward for some eighty miles. The following portions of the railroad were open for traffic by the first part of 1915, and they form about half of the entire length and also represent the most difficult parts of the work, being situated in mountainous country, while the parts remaining to be done, especially in Mesopotamia, go through a relatively flat country: Taurus region, 176 miles; Adona plain, 110 miles; Amanus Mountains and the Euphrates, 160 miles; Babylonia, 82 miles. To these must be added the short Adana-Mersina branch of 41 miles length which the Bagdad company acquired, and at the present time this represents the only sea access for the Asia Minor portions of the railroad. There are thus some 570 miles of railroad in operation, while the total distance from Konia to Bassorah is 1,360 miles, so that the working part represents 42 per cent of the total. Besides the main part of the line just mentioned, there are some nine branches varying from 30 to 125 miles in length for which the plans are already drawn up, and these figure for 551 miles. These branches, together with the main line and the Adana-Mersina and Toprak-Alexandrette portions, which are already open for traffic (length 79 miles), make a grand total of 1,990 miles of railroad in this part of the Orient.

Mediterranean Fever and Goats' Milk

Doctors Godard and Porcher, of the Lyons Veterinary establishment, recently made a very clear *resumé* of the questions relating to what is known as Mediterranean fever, sometimes called Malta fever, and by other names. It was first noticed at Malta, and is caused by a special microbe, the *micrococcus melitensis*, being now disseminated in most of the countries around the Mediterranean, and it is also found in Africa, China, etc. The malady comes from drinking raw milk of goats which have the affection; and as this animal furnishes nearly all the milk in these regions, this gives the explanation as to the area of country in which the disease appears. The goats are but little affected themselves, and give the usual amount of milk, so that no warning is had of the presence of microbes. But human beings can be affected for weeks at a time, the fever resembling typhus in some ways, though it is not nearly as dangerous. The goat eliminates the microbes by the milk and in other ways, and the milk affords a good medium for the development of the germs. Boiling the milk at once kills the microbes. Chemical analysis appears to be insufficient to reveal the presence of the germs, and a bacterial analysis is required.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, JANUARY 6th, 1917

Published weekly by Munn & Company, Incorporated. Charles Allen Munn, President; Frederick Converse Beach, Secretary; Orson D. Munn, Treasurer; all at 233 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter

Copyright 1917 by Munn & Co., Inc.

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) . . . . " 4.00

The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 233 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Back Numbers of the Scientific American Supplement

Supplements bearing a date earlier than January 2nd, 1915, can be supplied by the H. W. Wilson Company, 39 Mamaroneck Avenue, White Plains, N. Y. Please order such back numbers from the Wilson Company. Supplements for January 2nd, 1915, and subsequent issues can be supplied at 10 cents each by Munn & Co., Inc., 233 Broadway, New York.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

Branch Office:
625 F Street, N. W.,
Washington, D. C.

Munn & Co.,
Patent Solicitors,
233 Broadway,
New York, N. Y.

Table of Contents

	PAGE
The Municipality in Industrial Hygiene.—By L. I. Harris	2
Trajectories of Projectiles Discharged at an Elevation of 45 Degrees	3
Armored Automobiles.—2 illustrations	4
Tambookie Grass and Papyrus From South Africa for Paper Making	5
The Nyala: A Recently Discovered African Mammal.—1 illustration	5
The Damping Waves and Other Disturbances in Mercury	5
Recent Work on Tsetse-Flies	5
Decay of the Teeth.—By Earl Brooks	6
Wolf's Comet (1916 b)	7
The Pottery Tree	7
Indian Dances of the Southwest.—By H. J. Spinden.—10 illustrations	8
Milan-Venice Canal	9
Obstacles to Success in Engineering.—By Sir M. Fitz-Maurice	10
The Essex Zeppelin.—Outlines of Zeppelin Design	11
The Alimentary Aspects of Whole-Meal Bread	11
Preparing an Offensive.—7 illustrations	12
The Temporary Stars.—By Maurice Fouché	14
Development of Our Potash Industry.—By F. M. deBeers	15
New Points About the Bagdad Railway	16
Mediterranean Fever and Goats' Milk	16